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## THE SCIENCE OF ORE DEPOSITS.

*Lehre von den Erzlagerstätten.* By Dr. R. Beck. I Theil. Pp. iv + 384. (Berlin: Borntraeger, 1901.)

IN striking contrast to the almost universal neglect with which the subject of ore deposits is treated in this country is the increasing attention that it is receiving from geologists and mining engineers abroad, and more especially in Germany and in the United States. In the recently published annual general report and statistics of the output of minerals in Great Britain, by Dr. C. Le Neve Foster, attention is called to the fact that our production of all metalliferous minerals, already small, is continually shrinking, and whilst this unpleasant fact may be the cause of the above-noted neglect of the study of ore deposits, it may equally well be an effect thereof, and may present one more example of the way in which we are being left behind by other nations in industrial pursuits, merely because we so uniformly disdain to study their scientific aspects.

The work now under review serves well to emphasise the difference between the treatment of scientific technology in the two countries; it is written by the professor of geology and of the science of mineral deposits at the ancient and famous Royal Mining School of Freiberg. In this country we have no ancient mining schools—perhaps even no mining schools at all, as the Germans understand this term—and not a single professorship devoted to the study of mineral deposits.

This latter subject has nowhere been the subject of more assiduous study than it has at Freiberg, and this fact alone would make the present treatise one of exceptional importance. Its author is, moreover, a recognised authority on the theory of ore deposits, and his work is marked with decided originality in many respects. The only difficulty in forming a fair estimate of it lies in the fact that the volume before us is only half a book, concluding abruptly in the middle of a chapter. It seems that the remainder is not to be published till next year, and as the present part does not include any table of contents it is impossible to say now what the scope of the completed work will be. It is hard to see what good end is to be served by this fragmental system of publication.

The most interesting point about any work on ore deposits is the system of classification and arrangement adopted in it. Dr. Beck commences his work by a division of all deposits into two main groups, (1) Primary, and (2) Secondary, the latter group including the deposits formed by the destruction of pre-existing ones, whether as alluvial deposits or by disintegration *in situ*. It is obvious that such a division is defective in many respects, apart from the fact that the two groups thus formed are of very unequal importance. In the first place it is impossible in many cases to predicate with certainty of an ancient deposit that it was primary in its origin, seeing that all traces of its original genesis may have been lost owing to wide-reaching metamorphism; and, again, there is no real genetic difference between a recent mineral deposit and an ancient one, and it is illogical to base the first great classificatory grouping upon a distinction of such little real importance. Worst of all, the author finds himself unable to maintain his own classificatory system. A striking example of this defect is his inclusion amongst the primary deposits of "bedded gold deposits of Palæozoic and Mesozoic age," the first example of which, given by him, is certainly an alluvial deposit of Cambrian age, whilst all the others were probably also alluvial deposits. Dr. Beck's inclusion of Tertiary and more recent alluvial deposits in his secondary group, whilst all alluvials older than Tertiary are included among primary deposits, is as arbitrary as it is unpractical, and, moreover, is in no way justified by his own definitions.

The group of primary deposits is here further divided into (*a*) *Syngenetic*, or such as were formed contemporaneously with the surrounding rocks, and (*b*) *Epigenetic*, or such as were formed subsequently; the first class is again subdivided into (1) Magmatic segregations, and (2) Stratified ore deposits, and the second class into (1) Fissure veins, and (2) Deposits that are not vein-like; the latter class is again further subdivided, but the deposits included in it are not covered by the present volume, so that their discussion must be deferred. Perhaps the least satisfactory group of the present classification is the first subclass of magmatic segregations, which is intended to cover ore deposits produced by magmatic differentiation from molten eruptive rocks. We doubt whether many geologists would even endorse fully the opening sentence of this section: "The origin of metals is, without doubt, the inaccessible interior of the earth's crust," more especially seeing that the main argument in support of this very dogmatic statement is based upon the high specific gravity of the earth as a whole, compared with that of the rocks composing its surface. This subclass is divided into three sections, namely, segregations of native metals, of oxidised ores and of sulphuretted ores respectively. The first section is especially unfortunate; the first examples quoted, namely, native iron in the island of Disko, nickeliferous iron at Awarua, New Zealand, and platinum in the Urals, are none of them mineral deposits in the sense in which Dr. Beck, quite correctly, defines the word, namely, deposits of mineral of economic importance; further, the last example, namely, the occurrence of native copper in the melaphyres of Lake Superior, is certainly not a case of magmatic segregation, but is a well-marked instance of an epigenetic deposit; and the only other example, that of the occurrence of gold in certain eruptive rocks, is in many cases neither of economic importance nor of indisputably magmatic origin. The next section, that of the oxidised ores, is more satisfactory in many respects, although doubts may well be entertained of the soundness of any system of classification that separates, as widely as Dr. Beck does, the iron ore deposits of Kirunavaara and Luossavaara from those of Gellivaara and Svappavaara, all four of which show very many and very interesting points of similarity. The third section, that of sulphuretted ores, is again open to doubt, and it seems as though more stress had been laid upon the accidental circumstance, whether a given deposit lies wholly within or merely in proximity to an igneous outburst with which it is probably genetically connected,

than upon the real genetic and morphological relations of the deposit. Hence it is that Dr. Beck places the pyritic deposits of Rio Tinto, Mount Lyell, &c., in quite a different group from those of Sudbury, although most authorities prefer to group them together. Moreover, it is only in very few of the examples cited under this head that the magmatic origin of the deposit can be said to be in any degree probable.

The class of the stratified ore deposits is better defined, although it would have been preferable to have either excluded altogether deposits that consist of ores disseminated through an otherwise barren bed, or else to have included all forms of this mode of occurrence; the attempt to class impregnations amongst the epigenetic deposits, and to include in the present class only such disseminations as were formed contemporaneously with the bed in which they occur, is necessarily unsatisfactory, for there are very few instances in which the true mode of origin of such deposit has been proved beyond the possibility of dissent. Another source of weakness in this classification is the inclusion here of typically lenticular deposits, whenever the lens lies parallel to the stratification. Here again a relatively accidental character has been emphasised whilst the real geological relations of the deposit have been lost sight of.

Dr. Beck is perhaps at his best in his classification of veins, although the method here adopted is purely empirical. Such important geological relations as those of the vein to the country rock are utterly disregarded, contact veins are not distinguished from true fissure veins, &c., whilst the classification relies entirely upon the mineralogical character of the vein filling. This is the old Freiberg classification, revised and extended, and though it is less satisfactory when applied to the world as a whole than it was when restricted to the Freiberg district, it is nevertheless interesting, and, to a certain degree, even useful. By far the worst portion, and the only one that is wholly unsatisfactory, is the attempt to classify the gold-bearing veins, the distinctions here drawn being far too artificial, and the lines of demarcation too imaginary.

It may be noted, by the way, that the well-known Sheba deposit is here classed as a vein, whilst the bulk of what is known about it tends to show that it is certainly a bed. It is also doubtful whether the majority of the cinnabar deposits are really veins, as they are here designated.

In pointing out that many and grave faults can be found with Dr. Beck's classification of ore deposits, nothing more is intended to be conveyed than that Dr. Beck has not succeeded where every one else has failed. It may be doubted whether any one has yet evolved a classification of ore deposits that satisfied anybody—even its author; the inherent difficulties of the subject are so great and so manifold that a satisfactory solution of the problem may, in the present state of the science, fairly be declared to be impossible. Classification apart, Dr. Beck's work forms a contribution of the utmost value to the study of ore deposits; his descriptions are concise and clear, and his illustrations are well selected, especially as regards German, Austrian and Scandinavian deposits. The section on faults is eminently satisfactory, and indeed it would be hard to point to any work in which this complicated portion of the subject has received better treatment. It is difficult to pass judgment on half a book, but it may fairly be said that if the remainder of the work is only equal to the first half, it will constitute one of the best works available on the subject of ore deposits, provided that it is furnished with thoroughly complete indexes, and not with the apology for an index that usually does duty in German works. As the ore deposits described are arranged in accordance with the author's own system of classification, a complete alphabetical subject-index, together with a complete alphabetical index of geographical names, are needed to make Dr. Beck's work the highly useful book of reference that its other merits entitle it to become.

H. LOUIS.

## THE THEORY OF "SCREWS."

*A Treatise on the Theory of Screws.* By Sir Robert Stawell Ball, LL.D., F.R.S. Pp. xix + 544. (Cambridge University Press, 1900.)

SIR ROBERT BALL'S "Theory of Screws" is one of the most notable modern extensions of theoretical dynamics. It is based on Poinsot's discovery that every set of forces, regarded as acting on a rigid body, is reducible to a force along one definite line and a couple round the line; combined with Chasles's discovery that every instantaneous motion of a rigid body is reducible to rotation round one definite line and translation along it—in other words to a screwing motion. The modes of reduction in the two cases are strictly analogous; a force along a line being the analogue of a rotation round the line, and translation in any direction being the analogue of a couple whose axis has this direction.

The theory of screws treats of these two subjects in conjunction. The definite line along which the force acts, or round which the body rotates, is regarded as the *axis* of a *screw*, and the ratio of the couple to the force in the one case, or of the translation to the rotation in the other, is called the *pitch* of the screw. The sign of the pitch indicates whether the screw is right-handed or left-handed, and is not altered by reversing the screw end for end.

It would be convenient to have some general name for anything which follows the laws of combination employed in these reductions. Clifford called it a *motor*. It might well be called a *screw-actor*. The resultant of two screw-actors may be called their *sum*.

When the screw-actor is a set of forces, Sir R. Ball calls it a *wrench*—a name which is not suggestive of a statical concept, but rather of force combined with motion. The name *forcive* seems more appropriate.

When the actor is a screw motion, Sir R. Ball calls it a *twist*, and the name *twist-velocity* is given to a screw-velocity. The twists considered in the theory of screws are, in general, supposed to be so small as to admit of simple superposition, quantities of the second order being negligible.

Five numbers are required for specifying a screw. Two will give the direction of the axis, two the intersection of the axis with a fixed plane, and one the pitch. From another point of view a screw is defined by the five ratios of the six components of a screw-actor.

The theory of screws lends itself with special readiness to the discussion of the movements of a body with a given number of degrees of freedom. A body with one degree

of freedom can only move on one definite screw. A body with two degrees of freedom can take two independent screw motions combined in any ratio. This gives an infinite number of resultant screws, all lying in one ruled surface (called a *cylindroid*) and having pitches distributed according to a simple law. All cylindroids have the same shape, and the linear dimensions of a cylindroid are proportional to the difference between the greatest and least pitch that can be found among its screws. A body with $n$ degrees of freedom has $n$ independent screw motions, $n$ being not greater than 6.

Any screw system which specifies the freedom of a body serves equally well for specifying aggregates of screw-actors of the forcive kind. For instance, if any multiple (integral or fractional) of a forcive on a screw A is compounded (additively or subtractively) with a forcive on a screw B, the resulting forcive will be on one of the screws of the cylindroid to which A and B belong.

A body limited to motion on one definite screw can move in either of two opposite directions, and when acted upon by a forcive will move in the direction for which the work done by the forcive is positive. When the forcive-screw is so related to the motion-screw that the work-rate for a small motion is zero, the body will be in equilibrium, the forcive being equilibrated by the reaction of the constraints. The two screws in this case are said to be *reciprocal*. The condition of reciprocity, when expressed in terms of the rectangular components X Y Z of force, $u$ $v$ $w$ of translation, L M N of couple, and $p$ $q$ $r$ of rotation, is

$$Xu+Yv+Zw+Lp+Mq+Nr=0\,;$$

and this will not be altered by interchanging the force X with the rotation $p$, the couple L with the translation $u$, and so on. Hence it is immaterial which of the two screws we assign to the forcive and which to the motion.

One degree of constraint subjects the 6 components, $u\ v\ w\ p\ q\ r$, of an instantaneous motion to one linear relation. It can accordingly be expressed by assigning proper values to the coefficients X Y Z L M N in the above equation of condition. One degree of constraint, therefore, limits the motion of a body to those screws which are reciprocal to one definite screw. Hence it can be deduced that two degrees of constraint limit the motion to screws reciprocal to all the screws of one definite cylindroid.

The system of screws on which a body can move which has $n$ degrees of freedom or $6-n$ degrees of constraint being called an *n system*, it can be shown that every $n$ system is reciprocal to a definite $6-n$ system. Each of these two systems is sufficient to define the other.

In a 5 system the axes of the screws include every line in space, each fitted with its proper pitch, and at every point there are a whole plane of screws of any assigned pitch.

Three or more screws are said to be independent when it is not possible to take screw-actors upon them whose sum is zero. Seven screws cannot be independent. If any 6 independent screws are taken, they will suffice for the specification of any 7th screw by 6 numerical coefficients, called *screw-coordinates*, an actor on the 7th screw being always a sum of multiples (generally fractional) of actors on the 6 screws of reference. It is possible, and usually preferable, to select screws of reference such that each is reciprocal to all the rest.

If a body is only free to move on a single screw, a forcive applied to it can be resolved into two forcives, one of which is reciprocal to the screw in question. This component can be ignored, as it does not influence the motion, which will accordingly be the same as if the other screw acted alone. If a body has $n$ degrees of freedom, a forcive applied to it can be resolved into 6 mutually reciprocal forcives of which $6-n$ are without influence on the motion, and the other $n$ may be regarded as acting alone.

The initial motion of a body produced by an impulsive forcive is, in general, on a different screw from the forcive; but in certain cases they are on the same screw. (This means that they have the same axis, and the work in translation is equal to the work in rotation). The screw, common to both, is then called a *principal screw of inertia*. There are, in general, 6 such screws for a perfectly free body, and $n$ for a body with $n$ degrees of freedom.

Again, for a body in stable equilibrium under forces which have a potential, there are certain screws (generally equal in number to the degrees of freedom) such that if the body be slightly displaced along one of these screws, and then left to itself either at rest or with a velocity on the same screw, it will oscillate on this screw. The screws thus defined are called *harmonic*, and are the proper screws to select for specifying small oscillations.

Besides physical deductions, of which the foregoing are specimens, the treatise contains numerous geometrical investigations, and an extension of the theory to non-Euclidian space.

At the end of the volume an interesting summary is given of the literature of the subject. It appears that Hamilton, in one of his papers on systems of rays, and Plücker, in his *New Geometry of Space*, anticipated Sir R. Ball's discovery of the cylindroid so far as regards its geometrical form without reference to pitch; and several theorems respecting systems of lines had been discovered which are particular cases of the general theory of screws.

An amusing and instructive "Dynamical Parable," which formed Sir R. Ball's Presidential Address to Section A at the 1887 meeting of the British Association, is given as an Appendix.

I wish to point out an erroneous statement with regard to finite displacements which occurs in all our works of highest authority on the motion of a rigid body. It is to be found in *Routh*, in *Thomson and Tait*, in *Williamson and Tarleton*, and in the introduction to Sir R. Ball's *Treatise*. The erroneous statement, in its plainest shape, is "The same displacement cannot be constructed on two different screws."

To see that this is wrong, consider the effect of giving a nut $9\frac{1}{4}$ turns on an ordinary iron screw. The same final position could obviously be attained by employing a screw of longer pitch and taking fewer turns, say $8\frac{1}{4}$ or $1\frac{1}{4}$ or $\frac{1}{4}$, and could also be attained by taking $\frac{3}{4}$ or $1\frac{3}{4}$ or $8\frac{3}{4}$ turns on a left-handed screw. The correct statement is that the axis and translation are unique, but that the rotation has any one of an indefinite number of values differing each from the next by $2\pi$, some of them being

positive (right-handed) and some negative (left-handed). If $l$ is the translation, and $p_0$ one value of the pitch $p$, the general value of $p$ is given by

$$\frac{1}{p} = \frac{1}{p_0} \pm \frac{2n\pi}{l}.$$

J. D. EVERETT.

## CULTIVATION AND MANUFACTURE OF TOBACCO.

*Le Tabac Culture et Industrie*. By E. Bouant. Pp. xii + 347. (Encyclopédie Industrielle, Paris: J. B. Baillière et fils, 1901.)

THE object of this work, as stated by the author in the preface, is to describe in popular scientific language the long series of operations necessary to transform a tiny seed into a good cigar or a pinch of scented snuff.

In a short introduction the author gives a *résumé* of the best ascertained facts concerning the origin of tobacco, its introduction into Europe, the prohibitions intended to hinder its use, and the change of tactics which have resulted in making the smoker contribute his quota to the public revenue.

Of the three parts into which the book is divided, the first two deal with the cultivation and manufacture of tobacco, and in the third part the economic, fiscal and hygienic aspects of tobacco are discussed.

In France the State controls the cultivation, and has the monopoly of the manufacture of tobacco; the author restricts his treatment of the subject almost entirely to a description of the methods of culture and manufacture followed in France.

Part i. commences with the botany of the principal species of Nicotiana and with a short account of the chemistry of tobacco. According to the analyses given on p. 24, tobacco ash contains a large proportion of salts of sodium (16 per cent. in the ash from the leaves of Havana tobacco). This is at variance with the general experience, for it is a remarkable and well-established fact that tobacco contains very little soda in any form.

The subject of culture is dealt with very fully, and a large amount of information is given concerning the choice of the most favourable soils and manures, the rotation of crops, sowing and transplanting, the various field operations during growth and ripening, and the final operations of harvesting, curing and packing.

In view of the experimental cultivation of tobacco which has been carried on in Ireland during the past season, it is interesting to note that the experience gained in France shows that Europe will never be able to dispense with American tobacco, as, with rare exceptions, European varieties are inferior in aroma and combustibility to those of American origin.

The manufacturing methods described in the second part are those employed in the great State tobacco factories of France. The methods of manufacturing cut and roll tobacco and snuff differ materially from those followed by British manufacturers, the result, no doubt, of the different fiscal regulations in the respective countries. The methods employed for making cigars and cigarettes, on the whole, are the same in both countries.

The book is well illustrated and, with the exception of a few photographic reproductions which leave much room for improvement, the illustrative figures are good and clear; typographical errors are not numerous. Altogether it is a very readable work, and, in addition to being interesting to the general reader, it should be of some service to those engaged in the cultivation and manufacture of "our holy herb Nicotian." J. W.

## OUR BOOK SHELF.

*Briefwechsel zwischen Franz Unger und Stephan Endlicher*. Herausgegeben und Erlaütert von G. Haberlandt. Pp. v. + 184. (Berlin: Borntraeger, 1899.)

AFTER the death of Unger's surviving son and daughter, a large portion of his correspondence was presented to the Botanical Institute of the University of Graz. From amongst these remains Prof. Haberlandt gives to the world the almost complete series of letters which passed between Unger and Endlicher from 1829 to 1847. There are 139 letters in all, of which about two-thirds are by Unger. Though the correspondence is, in large part, concerned with their own botanical labours, all the more important contemporary contributions to Botany are discussed between the friends. At the date of the opening of this correspondence, neither of the writers held an independent botanical post. Unger, who had deserted the law and qualified in medicine, in 1830 became a medical officer at Kitzbühel, in the northern Tyrol. Here, during his five years' sojourn, he collected the material for and wrote his now classic "Einfluss des Bodens auf die Vertheilung der Gewächse." This was the first attempt at a physiological flora, and Unger was justly proud of his achievement. This and other work paved the way to the professorship at Graz, to which he was appointed in the autumn of 1835, and which he held till Endlicher's death. Endlicher, the author of the well-known "Genera Plantarum," was made keeper of the botanical department in the Hof Museum, at Vienna, within a few months of Unger's appointment to Graz. Many common undertakings were mooted between the friends, and the most notable of those which reached accomplishment was their joint "Lehrbuch der allgemeinen Botanik," published in 1843. Its inception and progress are very fully set forth in the letters, and this portion of the correspondence will be read with interest as effectively contrasting the character and temperament of these two men. That Schleiden should have chosen the same time to bring out his remarkable "Grundzüge der wissenschaftlichen Botanik" was an event which could not fail to impress the joint authors. Unger, with characteristic outspokenness, writes:—"What do I think about Schleiden? He is an excellent fellow, though I don't agree with him entirely. We have wanted a man like this for a long time. It is by him—not by us—that a new epoch is created in our science." Another part of the correspondence, that relating to Unger's discovery of the ciliated zoospores of *Vaucheria*, is also full of interest. The headstrong and enthusiastic Unger insists on announcing his discovery in the form of a series of popular letters under the title "The Plant at the Moment of becoming an Animal," with an absurd quotation from Oken (the nature-philosopher) as motto. This intention draws from Endlicher one of the best letters in the book (No. 100); but it is quite lost upon Unger.

The correspondence is preceded by an able appreciation of the two botanists by Prof. Haberlandt, the present occupant of Unger's chair at Graz; whilst, by way of conclusion, there is printed a series of documents which tends to show that Endlicher died a natural death and did not commit suicide, as has been generally believed.

*The British Journal Photographic Almanac*, 1901. Edited by Thomas Bedding. Pp. 1552. (London: Henry Greenwood and Co., 1900).

THE fourth annual issue of this photographic almanac seems to be as popular as ever, judging by the great amount of matter contained in the present volume There are no less than 1552 pages, about 500 of which form the text. The arrangement of the book is the same as that adopted last year. There are over eighty articles on practical subjects, written by photographers, and these contain many useful hints which should be of service to those who utilise the experience of others. The "epitome of progress of the year," compiled by the editor, is very interesting reading, references to the most important advances being liberally made. "Recent novelties in apparatus" and "practical notes and suggestions of the year" also form no inconsiderable portion of the volume. The great collection of formulæ, tables, measures, photographic societies of the United Kingdom, &c., makes the volume a necessary accessory to any photographic studio.

Among the mass of material will be found some excellent illustrations, the frontispiece being a bromide print by Messrs. Morgan and Kidd. Not the least useful portion of this volume is the great collection of advertisements of most of the photographic manufacturers and dealers. The volume is quite up to, if it does not exceed, the standard of last year, and should be in the possession of all photographers. The price of one shilling brings it within the reach of all.

*The Lead Storage Battery*. By Desmond G. Fitz-Gerald. Pp. xi + 383. (London: Biggs and Co., no date.)

IN spite of the great industrial application of the accumulator, the theory of its working is in a very unsatisfactory state; and, moreover, those who desire to obtain information on the subject are obliged to seek for it in the publications of scientific institutions. Mr. Fitz-Gerald's book is a very useful summary of the leading facts and theories of the subject. Whilst fulfilling in some respects the objects of a text-book, it is much more than a text-book. Mr. Fitz-Gerald is able to speak with authority on both the chemical and electrical aspects of the storage cell, and his criticisms of existing types and suggestions of possible improvements will be found in many cases very valuable indications of what are likely to prove profitable lines of research. At the same time the book should be in the hands of any one who has to deal with accumulators, especially electrical engineers, who too often are quite ignorant of the chemistry of the subject. Besides discussing the various theories of the accumulator, the author gives an interesting account of its development, and descriptions, which are, we are inclined to think, too brief, of the different types of cell in use.

Mr. Fitz-Gerald apologises in the preface to the book for its possessing the defects of a compilation from notes made from time to time. It would have been better if, instead of making this apology, the author had removed the defects and had made the book a more consecutive work. It is difficult to make out to whom the book is intended to appeal, as in some instances elaborate calculations are entered into on points so elementary as to be quite childish, whilst in others a knowledge of chemistry is assumed which we doubt if the average electro-chemist possesses and feel sure is not possessed by the majority of electricians. In addition, the parts devoted to the history and theory of the subject respectively are intermixed without any apparent reason, and lose greatly in continuity and clearness in consequence. These defects are the more to be deplored as it is to be feared that they will discourage many from reading the book.

*The Elements of Inorganic Chemistry*. For Use in Schools and Colleges. By W. A. Shenstone, F.R.S. Pp. xii + 506. (London: Edward Arnold, 1900.)

THE object of the author of this elementary text-book is clearly stated in his preface. He says:—

"I have endeavoured to provide a book which begins with a course of experimental work for quite young students, and develops at the later stages into a text-book suitable for those who are older—that is, into a text-book containing fewer facts than those written solely for senior students, and in which the powers of young workers are more carefully kept in view in the earlier and middle parts than is necessary in the case of books written for students of a different type."

The book is divided into five parts. Part i. is chiefly taken up with the study of water and air, as exemplifying some of the principal types of chemical action and physical properties; Part ii. treats of the laws of combination and the atomic theory; Part iii. of the non-metals and their principal compounds; Part iv. of chemical affinity, heat changes, electrolysis, spectrum analysis and crystallography; Part v. of the metals and their chief compounds.

Directions are given for the performance of several hundreds of experiments, most of which can be done by the student himself. These directions, like the diagrams of apparatus which illustrate them, are very simple and clear.

The book seems extremely well adapted to the wants of the class of students the author has in view. Any youth of ordinary intelligence who works through the volume under the supervision of a competent demonstrator will acquire, not only an adequate knowledge of the facts of chemistry, but also sufficient theory to enable him to range and systematise these facts and to understand their general bearing.

*The Thompson-Yates Laboratories Report*. Edited by Profs. R. Boyce and C. S. Sherrington. Vol. i., Reprints, 1898–99; Vol. ii., Reprints and Reports, 1898–99; Vol. iii., Part 1, 1900. (Liverpool: University Press.)

THESE three handsome volumes testify to the energy and vitality of the Liverpool school. After a preliminary account of the laboratories founded by the munificence of the Rev. Thompson-Yates, vol. i. is devoted to neurology, and contains papers and reprints by Profs. Sherrington and Boyce, and Drs. Warrington, Laslett and Grünbaum, of which the one by the first-named author, upon the peripheral distribution of some spinal nerves, forms the *pièce de resistance*, occupying more than half the book. There are also interesting papers upon the changes found in lead paralysis and upon the muscle-spindles in pseudo-hypertrophic paralysis. In the latter, Grünbaum considers that his observations support the theory that this disease is a primary one of the muscles.

The first half of vol. ii. contains papers and reprints in bacteriology, hygiene and morbid anatomy, of which Dr. Balfour Stewart contributes three on plague—its diagnosis, and on the active constituents of Haffkine's prophylactic, Dr. Annett an interesting *résumé* of the tubercle-like bacilli in butter, and the same author an experimental inquiry on the use of boric acid and formaline as milk preservatives, in which he shows that kittens fed on milk containing these two substances are injuriously affected. The account of the morbid anatomy and pathology of a case of myelopathic albumosuria, by Drs. Bradshaw and Warrington, is a valuable contribution to our knowledge of this very rare disease, which was first described by Bence Jones, and of which only seven other cases have been recorded. Next follow the reports of the various departments and, as a supplement, Profs. Boyce and Herdman's report on oysters and disease, and the report of the Malarial Expedition to West Africa.

Vol. iii. is similarly mainly bacteriological. Balfour Stewart shows the wide distribution of the *Bacillus enteritidis sporogenes* of Klein, MacConkey contributes a paper on the differentiation and isolation of the *Bacillus coli* and *Bacillus typhosus* from mixtures by means of media containing bile salts.

The printing, illustrations and general "get-up" of the volumes are excellent. There is, perhaps, a tendency to needless detail in some places, as, for example, in the list of milk samples, but many of the papers are contributions of real scientific value.

*Einführung in die Stöchiometrie.* Von Joachim Biehringer. Pp. xviii + 498. (Brunswick: F. Vieweg und Sohn, 1900.)

THIS book, which differs greatly from the ordinary text-books of chemistry, has for sub-title "A study of the quantitative composition of substances and the properties connected therewith." So far as subject-matter is concerned, it covers much the same ground as Part i. of Ostwald's *Allgemeine Chemie*, the general arrangement evidently being inspired by that work. The treatment, however, is radically different, theoretical matters, although adequately outlined, being made subservient to their practical applications, which are illustrated by a wealth of numerical examples. The arithmetical exercises are, in fact, the chief feature of the book. There are altogether three hundred of them, each of which is provided with a fully-worked solution, the method of calculation being carefully explained. The problems are well-selected, unpedantic, and of real value in their application to laboratory or technical work. Some are, perhaps, a little far-fetched, but even these are instructive, and almost always possess some human interest. For example: "It is desired to convert into sparkling wine 1000 litres of new wine containing 10 per cent. by volume of alcohol and 0·5 per cent. of unfermented sugar. How much cane-sugar must be added in order that after fermentation the wine may have a pressure of 5 atmospheres, the temperature of the cellar being 12°?" The student will be especially grateful for the numerous examples of the calculation of molecular weights, and of the results of analysis, both gravimetric and volumetric. Altogether no better guide could be desired to chemical and elementary physico-chemical calculations.

*Travail des Metaux dérivés du Fer.* Par L. Gages, Capitaine d'Artillerie. "Encyclopédie Scientifique des Aide-Memoire." Pp. 202; 40 illustrations. (Paris: Gauthier-Villars, 1900.) Price 2 fr. 50 centimes.

THIS new member of the excellent *aide-memoire* series worthily upholds the reputation built up by its predecessors. It gives in clear, terse language a short summary of the mechanical and thermal treatment to which steel is subjected to prepare it for use in the industries, and the greater part of the remainder of the book is given up to considerations of the theory of hardening and tempering. The solution theory of the constitution of steel is so firmly established in France that it is now taken as an authoritative explanation of the facts; but some of the thermal and micrographic evidence is given, on which the theory is based. In dealing with "steels" which owe their distinctive properties to the admixture with iron of elements other than carbon, Captain Gages makes a new departure in classifying them in accordance with a law enunciated by Sir William Roberts-Austen, which sets forth the fact that elements having a lower atomic volume than iron tend to harden steel, and those with a higher atomic volume to soften it and make it malleable. This classification of a large class of materials which are comparatively new to engineers seems useful and businesslike, and, indeed, Captain Gages, by bringing into a brief and readable form the results of the labours of Osmond, Werth and many others, has done much to popularise the whole subject.

## *LETTERS TO THE EDITOR.*

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Stability of a Swarm of Meteorites.

REFERRING to my paper in NATURE of October 11, "On the Stability of a Swarm of Meteorites, &c.," Mr. R. B. Hayward, F.R.S., has called my attention to the fact that the supposition, made near the foot of the first column, that

$$\xi = a\cos\omega t,\ \eta = b\sin\omega t,$$

in other words that the relative orbit of the particle under consideration is an ellipse of semi-axes $a$, $b$, involves an eccentricity,

$$\sqrt{1 - b^2/a^2},$$

for that ellipse of amount

$$n\sqrt{3/(\mu - \omega^2)} = \sqrt{6n/(\sqrt{n^2 + 16\mu} - n)},$$

so that in strictness the relative orbit cannot be a circle unless $n = 0$.

This point ought, perhaps, to have been brought out in my paper as illustrating the rudeness of the approximation of the shape of the swarm to a sphere in any actual case, a matter which I touched on in speaking of the inutility of further refinements, such as the effect of the ellipticity of the swarm's orbit round the sun. However, for any probable swarm in the solar system, $n^2/\mu$ must be a very small fraction, and so $\omega^2$ may be very nearly equal to $\mu$ (if the centre of the swarm is fixed, $\mu = \omega^2$), while $b/a$ is nearly unity.

Mr. Hayward suggests that the same difficulty may have been felt by others, and that therefore the above explanation may be desirable.

ANDREW GRAY.

The University, Glasgow, December 29, 1900.

### An Artificial Representation of a Total Solar Eclipse.

IN preparing for polarisation experiments on the solar corona, it is extremely desirable to have an artificial corona as nearly as possible resembling the reality for preliminary work. The only device of the kind that has been used to my knowledge was the arrangement described by Wright in his eclipse report, consisting of a cardboard funnel, lined with black cloth, with a light at the back. This gives a ring-shaped illuminated area radially polarised. It is believed that the contrivance about to be described will be found far better adapted to work of this sort, for the artificial corona in this case resembles the real so closely as to startle one who has actually witnessed a total solar eclipse. The polarisation is radial, and is produced in the same way as in the sun's surroundings, and the misty gradations of brilliancy are present as well. So perfect was the representation that I added several features of purely æsthetic nature to heighten the effect, and finally succeeded in getting a reproduction of a solar eclipse which could hardly be distinguished from the reality, except that the polar streamers are straight, as drawn by Trouvelot, instead of being curved, as all the recent photographs show them. The curious greenish-blue colour of the sky, and the peculiar pearly lustre and misty appearance are faithfully reproduced. For lecture purposes an artificial eclipse of this sort would be admirably adapted, and I know of no other way in which an audience could be given so vivid an idea of the beauty of the phenomenon. Drawings and photographs are wholly inadequate in giving any notion of the actual appearance of the sun's surroundings, and I feel sure that any one will feel amply repaid for the small amount of trouble necessary in fitting up the arrangement which I shall describe.

A rectangular glass tank about a foot square on the front and five or six inches wide, and a six candle-power incandescent lamp are all that are necessary. The dimensions of the tank are not of much importance, a small aquarium being admirably adapted to the purpose. The tank should be nearly filled with clean water, and a spoonful or two of an alcoholic solution of mastic added. The mastic is at once thrown down as an exceedingly fine precipitate, giving the water a milky appearance. The wires leading to the lamp should be passed through a short glass tube, and the lamp fastened to the end of the tube with sealing wax, taking care to make a tight joint to prevent

the water from entering the tube (Fig. 1). Five or six strips of tinfoil are now fastened with shellac along the sides of the lamp, leaving a space of from $\frac{1}{2}$ to 1 mm. between them. The strips should be of about the same width as the clear spaces. They

FIG. 1.

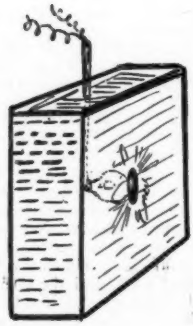

FIG. 2.

are to be mounted in two groups on opposite sides of the lamp, and the rays passing between them produce the polar streamers. The proper number, width and distribution of the strips

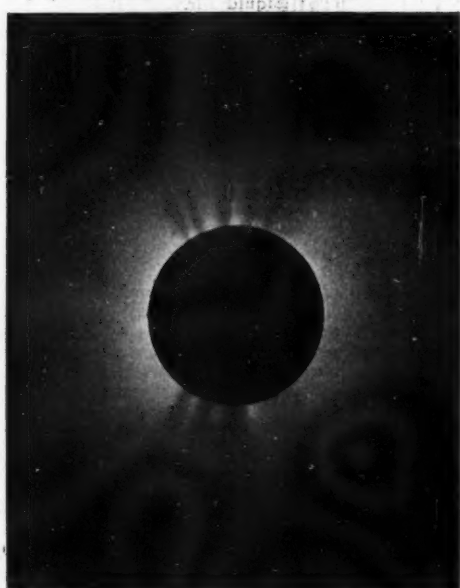

FIG. 3.

necessary to produce the most realistic effect can be easily determined by experiment. A circular disc of metal a trifle larger than the lamp should be fastened to the tip of the lamp with sealing-wax, or any soft, water-resisting cement; this cuts off the direct light of the lamp and represents the dark disc of the moon. The whole is to be immersed in the tank, with the lamp in a horizontal position and the metal disc close against the front glass plate (Fig. 2). It is a good plan to have a rheostat in circuit with the lamp to regulate the intensity of the illumination. On turning on the current and seating ourselves in front of the tank, we shall see a most beautiful corona, caused by the scattering of the light of the lamp by the small particles of mastic suspended in the water. If we look at it through a Nicol prism we shall find that it is radially polarised, a dark area appearing on each side of the lamp, which turns as we turn the Nicol. The illumination is not uniform around the lamp, owing to unsymmetrical distribution of the candle-power, and this heightens the effect. If the polar streamers are found to be too sharply defined or too wide, the defect can be easily remedied by altering the tinfoil strips. The eclipse is not yet perfect, however, the illumination of the sky background being too white and too brilliant in comparison. By adding a solution of some bluish-green aniline dye (I used malachite-green), the sky can be given its weird colour and the corona brought out much more distinctly. If the proper amount of the dye be added, the sky can be strongly coloured without apparently changing the colour of the corona in the slightest degree, a rather surprising circumstance, since both are produced by the same means.

We should have now a most beautiful and perfect reproduction of the wonderful atmosphere around the sun, a corona of pure golden white light, with pearly lustre and exquisite texture, the misty streamers stretching out until lost on the bluish-green background of the sky. The rifts or darker areas due to the unequal illumination are present as well as the polar streamers. The effect is heightened if the eyes are partially closed.

A photograph of one of these artificial eclipses is reproduced in Fig. 3. Much of the fine detail present in the negative is lost in the print, and still more will doubtless go in the process of reproduction. No especial pains were taken to get the polar streamers just right.

R. W. WOOD.

University of Wisconsin.

## Sexual Dimorphism.

I CRAVE your leave to reply to one part of the careful and considerate criticism with which Prof. Meldola has honoured my book on "Sexual Dimorphism." He declares his inability to see any force in one of the crucial arguments of my theory, namely, that concerning unisexual inheritance, or, in Darwin's phraseology, heredity as limited by sex. He asks, Why should characters mechanically impressed upon the male during a particular period of his life be hereditary, and characters arising by spontaneous variation at that period not be hereditary? But this is not the question we have to consider. The question discussed in my argument is, Why should characters arising by spontaneous variation at any period of life in one sex be inherited by offspring of the same sex, and not by offspring of the opposite sex?

Prof. Meldola maintains that *on either hypothesis* all characters must originate in an individual which must be either male or female, and asks why there should ever be any blending of characters at all. He appears, therefore, to suppose that all spontaneous variations are inherited only by offspring of the same sex as the parents in which they occurred. It is well known that this is not the case. Many instances are on record in which additional fingers have occurred in a man, and have been inherited by both male and female descendants. I have myself much experience in breeding mice, and in them, although the colours of the parents do not blend perfectly or always in the offspring, yet the colour of the male parent is not more often inherited by male progeny than by female. On the other hand, blending often occurs, and if a male pouter pigeon is matched with a female fantail, the male progeny are not perfect pouters, nor the female perfect fantails.

Darwin has discussed the question in a well-known passage ("Descent of Man," 2nd edit. p. 231): "If a breeder observed that some of his pigeons varied into pale blue, could he, by long continued selection, make a breed in which the males alone should be of this tint, whilst the females remained unchanged? I will here only say that this, though perhaps not impossible, would be extremely difficult; for the natural result of breeding from the pale blue males would be to change the whole stock of both sexes to this tint. If, however, variations of the desired

tint appeared, which were from the first limited in their development to the male sex, there would not be the least difficulty in making a breed with the two sexes of a different colour, as, indeed, has been effected with a Belgian breed, in which the males alone are streaked with black."

The necessary assumption of the theory of sexual selection therefore is, not that spontaneous variations are always inherited unisexually, but that congenital variations occur and have occurred in certain species which from the first were limited in development to one sex. The selection or preservation of such variations does not explain their unisexual or other limitations. It might be suggested or maintained that spontaneous hereditary variations, limited to one sex, to one period of life, or to one season of the year, are liable to occur and have occurred in all species, but have been only selected and preserved in some. But I do not know that this is maintained by selectionists, and at any rate I know of no evidence to support such a contention.

The questions I have considered are, Why have such hereditary variations occurred in some species and not in others? Why are they so closely correlated with the functional activity of the testes, actually failing to develop normally in castrated animals? Why do they always, so far as we know, correspond to the special stimulations involved in the behaviour of the animals under sexual excitement?

Prof. Meldola asks, Why should my view be supposed to account for the limitation of the male characters to the male and the Darwinian view to fail? Surely it is obvious that Darwin's theory merely assumes that variations have occurred which from the first were limited in development as the characters are, while my theory is that they were so limited in development because they were due to stimulations similarly limited.

When Prof. Meldola suggests that the female has had any tendency to inherit the male characters eliminated by natural selection, he seems to me to be repeating an empty formula. There is no ground for supposing that any selection could eliminate such a tendency, and, further, it is an established fact that the tendency has not been eliminated; the female inherits the characters potentially, but in her they usually remain suppressed and latent to appear in actual development under certain conditions. J. T. CUNNINGHAM.

Penzance, December 29, 1900.

MR. CUNNINGHAM's reply does not appear to me to shed any new light upon the subject of unisexual inheritance, and I can only adhere to the statement expressed in my review. Why he credits me with the supposition "that all spontaneous variations are inherited only by offspring of the same sex as the parents in which they occurred" is beyond my comprehension. There is nothing in my criticism of his views which warrants this, and I need hardly add that the facts which prove such a supposition to be erroneous are quite as familiar to me as they are to Mr. Cunningham. The real point at issue is a comparatively simple one. The author of the book insists that the theory of sexual selection fails to account for unisexual inheritance, and that his theory does account for this phenomenon. Again, it may be asked, why? The answer given above is simply a repetition of his opinion, as already published—the characters are so limited "*because they were due to stimulations similarly limited.*" That is to say, that in every case where the male possesses distinctive secondary sexual characters, these have been produced by direct stimulations acting on the male only, and are, therefore, limited by heredity to the male. Now Mr. Cunningham has just pointed out that transference of male characters to the female does take place, that blending of characters may, and does, occur, and that male characters may, under certain circumstances, appear in the female—a series of facts which we have all been familiar with ever since we became students of Darwin's writings. These facts are absolutely inexplicable on the "direct stimulation" theory. If the stimulations which produced a male character necessitate the restriction of that character to the male, then the only way of escaping from the dilemma in which the author has placed himself is to make one of two additional assumptions:—(1) The characters so blending are not secondary sexual characters, which would be simply resolving the question at issue into a verbal juggle; or (2) that in all cases where there is blending or transference, the same "stimulations" have acted upon both sexes. This last assumption is, however, opposed to the entire spirit of Mr. Cunningham's book, the whole burden of which is that there has been *dissimilarity* of "stimulation" between the sexes.

I should like to add, in concluding, that my own opinion as to the value of Mr. Cunningham's book is in no way shaken through my inability to accept his amended Lamarckism. Out of gratitude for the body of facts which he has collected, I will even go so far as to meet that much-hackneyed reproach of "repeating an empty formula" which anti-selectionists are so fond of using. For, after all, an empty formula, being (by definition) a formula containing no terms, is a negative kind of expression, and if it cannot, by virtue of its vacuity, do much to advance science, it cannot, on the other hand, do any harm. But a formula which contains erroneous terms may throw us off the track altogether, and my contention is that erroneous terms exist in Mr. Cunningham's formula. R. MELDOLA.

### Direction of Spirals in Horns.

IN investigating the causes of directions of various spirals, I discovered a certain law and order in the arrangement of the direction of the spiral in horns which will interest many of your readers.

(1) That in the antelopes the right-hand spiral is on the left of the head, and the left-hand spiral on the right of the head (crossed). (2) That in sheep the right-hand spiral is on the right of the head, and the left spiral on the left side of the head (homonymous, or same name). The *wild* goats agree with the antelopes in regard to the spiral direction of their horns (crossed), and the oxen agree with the sheep in cases where the spiral can be noted (homonymous). Exceptions are not numerous and not difficult to remember, but this letter is not intended to do more than record the usual rules for spiral directions in horns.

If these observations be of value in clearness of description of a difficult point, it will be a gain; and they may also prove useful in classification. By taking a corkscrew (or a right-handed spiral) in the hand, it is easy to verify on the horns themselves the direction of their spiral curves. GEORGE WHERRY.

Cambridge.

### Liquid Air.

THE notion that Virgil had an idea of "liquid air" because he speaks of "liquidus aer," is like the idea that Euripides was a smoker because a line of his may have begun

τὸ βακχικὸν δώρημα δός.

But there is a very curious anticipation of Prof. Dewar's discovery in Lucian's "Vera Historia" Book ii 89. Lucian there tells us that the inhabitants of the moon drink ἀὴρ ἀποθλιβόμενος ἐς κύλικα, "air squeezed or compressed into a goblet." I do not know whether liquid air has yet been used as a beverage, but in other respects the passage seems to be an exact description of the substance in question. J. ADAM.

Emmanuel College, Cambridge, December 30, 1900.

### A Nest of Young Starlings in Winter.

WHILE a friend was walking through his fields near Broxbourne on Sunday afternoon, the 6th inst., he noticed a starling flying towards an an old elm with some food in its bill, and on going up to the tree he found a nest containing young birds. No doubt they are dead by this time, on account of the severe cold and the difficulty the old birds found in obtaining food for them. R. H. F.

January 8.

## *SOME ANIMALS EXTERMINATED DURING THE NINETEENTH CENTURY.*

WHILE the century which has just closed may fairly lay claim to the gratitude of posterity on account of the magnificent tale of zoological work accomplished during its course, it is, on the other hand, undoubtedly open to the charge of having permitted the total extermination of not a few animals, and of having allowed the numbers of others to be so reduced that their disappearance, at least as truly wild creatures, can scarcely be delayed very many years longer. Possibly, if not prob-

ably, the sweeping away of the enormous herds of many species, like those of the American bison, may have been an inevitable accompaniment of the march of civilisation and progress; but there is no sort of excuse to be made for the fact that in certain instances naturalists failed to realise that species were on the very verge of extermination, and that they were actually allowed to disappear from the world without being adequately represented in our museums. Nor is it by any means certain that even the present generation is altogether free from reproach in this matter, although it cannot be said that any species hovering on the verge of extermination are absolutely unrepresented in collections. Whether, however, sufficient specimens of such species are being preserved for our successors may be an open question.

It is not our intention in this article to allude to the host of animals whose numbers have been reduced in such a wholesale manner during the century as to render them in more or less immediate danger of impending extermination, but to confine our attention in the main to those on whom this fate has already fallen. And here it may be mentioned with satisfaction that India enjoys a remarkably good record in this respect, for, so far as we are aware, it has not lost a single species of mammal, bird or reptile, either during the nineteenth century or within the period of definite history. It is true that the numbers and range of the Indian lion have been sadly curtailed during the last fifty years, and that if steps are not promptly taken for its protection that animal may, ere long, disappear from the Indian fauna. But, at any rate, it has not done so at present; and even were it exterminated in the country, this would not mean the extermination of a species, and possibly not even of a local race, since it is not improbable that the Persian representative of the lion (which is still abundant) may not be distinguishable from the Indian animal. Of large animals peculiar to India, perhaps the great Indian rhinoceros is the one that requires most careful watching in order that its numbers and its range may not be unduly reduced before it is too late to take adequate measures for its protection. And in this connection it is perhaps legitimate to call the attention of sportsmen and native princes to the urgent need of a fine specimen of this magnificent animal for the collection of the British Museum.

We have said that the century is responsible for the extinction of no inconsiderable number of the world's animals. But it must not for one moment be supposed that, within the historic period, no such exterminations by human agency had taken place in previous centuries. We have to go back so far as the year 1615 for the last evidence of the existence, in a living state, of the great flightless rail (*Aphanapteryx*) of Mauritius and Rodriguez; while the journal of the mate of the *Berkley Castle*, in 1681, is the last record of the dodo being seen alive. Again, the tall and flightless solitaire of Rodriguez is not definitely known to have been met with by Europeans after 1691, although there is some evidence to indicate that it may have lingered on in the more unfrequented portions of the island till as late as 1761. Of the extinct géant, or Mauritian coot (*Leguatia*), we have no evidence of its existence subsequent to 1695; while our last record of the crested parrot (*Lophopsittacus*) is as far back as 1601. Again, the great northern sea-cow (*Rhytina gigas*), which was only discovered on the islands of Bering Sea in the year 1741, had entirely ceased to exist by about 1767. Moreover, the giant tortoise of Réunion appears to have ceased to exist on its native island previous to the dawn of the nineteenth century, although at least one exported example has survived till our own day.

Neither can the nineteenth century be held responsible for the extermination of the South African blaauwbok (*Hippotragus leucophoeus*), a smaller relative of the familiar roan antelope, since the last known example is believed to have been killed in or about the year 1799. It had always a curiously restricted habitat, being confined to a small area in the Swellendam district.

On the other hand, the great auk is a bird whose loss we owe to the carelessness of the naturalists of the middle of the nineteenth century, for there is little doubt that if protective measures had been taken in time it might have been alive at the present day. From the American side of the Atlantic it probably disappeared somewhere about the year 1840; while the summer of 1844 witnessed the destruction of the last European pair of this remarkable bird, the last British representative having been hunted to death in the neighbourhood of Waterford Harbour ten years previously.

One of the most sad stories of extermination, and that, too, at a comparatively recent date, is revealed in the case of the South African quagga. According to Mr. H. A. Bryden, who has devoted a great deal of attention to the subject, the extermination of this zebra-like species in the Cape Colony took place between the years 1865 and 1870, and probably between the latter year and 1873 in the Orange River Colony, which was its last stronghold. The extermination of this species may be attributed entirely to the pernicious trade of hide-hunting, for in the first half of the century it was to be met with in thousands on the grass *veldt*, and formed the staple food of the Hottentot farm labourers of the Graaf Reinet and many other districts. What makes the matter still more melancholy is that specimens of the animal could easily have been procured in any numbers, both for our menageries and our museums, but that (probably owing to the circumstance that naturalists were ignorant of its impending fate) no steps were taken in the matter. In the year 1851 a female was purchased by the Zoological Society of London, while seven years later a male was presented to the same body by the late Sir George Grey. The latter survived till 1872, and was thus one of the last survivors of its race. Although the fact of the practical accomplishment of the extermination of the species at that time appears to have been unknown in London, the skin of Sir George Grey's specimen was luckily preserved, and may now be seen mounted (albeit in a somewhat worn and faded condition) in the British Museum as the solitary representative of the species. Fortunately the skeleton of this specimen was likewise preserved for the national collection.

Several photographs of the above-mentioned individual are in existence, and the Royal College of Surgeons possesses a small oil-painting, by Agassiz, of one of a pair of quaggas which were driven in harness by Mr. Sheriff Parkins in Hyde Park early in the nineteenth century. Of these two animals the College likewise possesses the skulls, which were acquired with the collection of Mr. Joshua Brookes on its purchase in 1828.

In addition to Sir George Grey's specimen, the British Museum formerly had the skin of a young quagga, in very bad condition, which was presented by the traveller William Burchell, and was subsequently described by Hamilton Smith as a distinct species, under the name of *Hippotigris isabellinus*. Apparently London museums possess no other relics of this lost species, of which, however, we believe there is an example in the museum at Edinburgh. As the animal yielded no trophies worthy the attention of the sportsman, it is unlikely that there are any specimens in private collections, unless, perchance, a skull or two may be in existence. The lack of other relics of such a common species affords a signal instance of lost opportunities, and should serve as a warning against our permitting a similar remissness to occur in the case of any other species threatened with extermination.

Mention has already been made of the extermination of the giant land tortoise of Réunion during the

eighteenth century; and in the early part of its successor four other species became extinct in the neighbouring islands of the Mascarene group, namely, *Testudo indica*, *T. triserrata* and *T. inepta* in Mauritius, and *T. vosmaeri* in Rodriguez. It has likewise been considered probable that the thin-shelled tortoise (*T. abingdoni*), of Abingdon Island, in the Galapagos group, is also no longer existing, although it was certainly alive as recently as 1875.

Of birds that have disappeared during the century, in addition to the great auk, reference may first be made to the black emeu (*Dromaeus ater*), of Kangaroo Island, South Australia. When this island was explored in 1803 by a French expedition these birds were abundant, and three were sent home to Paris, where a pair lived till 1822. On their death, the skin of one and the skeleton of the other were mounted for exhibition in the Paris Museum, where they still remain. Of the third specimen no record was obtainable till 1900, when, as already noticed in this journal, its skeleton was discovered by Prof. Giglioli in the museum at Florence. These three priceless specimens are the only examples of a species which became extinct in the native state previous to the death of the Paris pair, and before it was even known to be different from the larger emeu of the mainland. For it appears that some years after the visit of the French expedition (to which Péron was naturalist) to Kangaroo Island, a settler squatted there and forthwith set to work to make a clean sweep of the emeus and kangaroos—a task in which he was only too successful.

Before the middle of the century another large bird appears to have made its final exit from this world. When Steller discovered the northern sea-cow in the islands of Bering Sea, he also brought to the notice of science a new species of cormorant (*Phalacrocorax perspicillatus*), which was especially interesting on account of being the largest representative of its kind, and likewise by the bare white rings round its eyes and the brilliant lustre of its green and purple plumage. Stupid and sluggish in disposition, Pallas's cormorant, as the species is commonly called, appears to have been last seen alive about the year 1839, when Captain Belcher, of H.M.S. *Sulphur*, was presented with a specimen by the Governor of Sitka, who also forwarded other examples to Petersburg. Captain Belcher's specimen is preserved in the British Museum, and three other skins are known to be in existence elsewhere.

The great white water-hen (*Notornis albus*), formerly inhabiting Lord Howe and Norfolk Islands, must be added to the defunct list. And the same is the case with the Tahiti rail (*Prosobonia leucoptera*) and Latham's white-winged sandpiper (*Hypotaenidia pacifica*), the latter of which in Captain Cook's time was abundant in the island above named, as well as in the neighbouring Eimeo. The New Zealand quail (*Coturnix novaezealandiae*) is likewise entered in the British Museum list as extinct. The beautiful "*Pigeon hollondais*," so-called from its plumage presenting the Dutch colours, and technically known as *Alectoroenas nitidissima*, is a Mauritian species whose extermination probably took place during the century. It is known solely by three examples, one of which is preserved at Port Louis, the second in Paris, and the third in Edinburgh.

Nor must we omit from our list two species of Kaka parrot, one of which (*Nestor productus*) was a native of Philip Island, while the home of the second (*N. norfolcensis*) was the neighbouring Norfolk Island. A species of parraquet (*Palaeornis exsul*), peculiar to the island of Rodriguez, is also believed to be exterminated.

Neither has the duck family escaped, for the well-known pied duck (*Camptolaemus labradorius*), an ally of the eider from the North Atlantic coast of America, appears in the defaulters' list, the last-known example having been killed in 1852.

Passing on to Passerine birds, a notable loss is the handsome crested pied starling, *Fregilupus varius*, which is believed to have become extinct about the middle of the century. Of the few remaining examples of this striking species one is preserved in the British Museum. Another species, exterminated within approximately the same period, is the gorgeous black and gold mamo, or sicklebill (*Drepanis pacifica*), of Hawaii, whence it was first brought to Europe by Captain Cook. As narrated in the "Birds of the Sandwich Islands," by Messrs. Scott Wilson and Evans, the extermination of this beautiful species is to be attributed to persecution for the sake of its yellow feathers, which were used for the cloaks of the native chiefs. About four specimens are known to be preserved in museums.

Of birds that have been locally exterminated, such as the burrowing petrel (*Œstrelata haesitata*), known in the Antilles as the diablotin, it is not our intention to speak on this occasion. And this article may accordingly be fitly brought to a close by an extract from Prof. A. Newton's "Dictionary of Birds," referring to two instances where species may have perished within the century without having ever come definitely under the notice of ornithologists. After stating that one Ledru accompanied an expedition dispatched by the French Government in 1796 to the West Indies, the Professor proceeds to observe that this explorer "gives a list of the birds he found in the islands of St. Thomas and St. Croix. He enumerates fourteen kinds of birds as having occurred to him then. Of these there is now no trace of eight of the number; and, if he is to be believed, it must be supposed that within fifty or sixty years of his having been assured of their existence they have become extinct. . . . If this be not enough we may cite the case of the French islands of Guadeloupe and Martinique, in which, according to M. Guyon, there were once found six species of Psittaci, all now exterminated; and it may possibly be that the macaws, stated by Gosse and Mr. March to have formerly frequented certain parts of Jamaica, but not apparently noticed there for many years, have fallen victims to colonisation and its consequences." R. L.

## CLIMBING IN THE HIMALAYAS.[1]

DURING an extended cycling tour in the East, the authors spent the summer months of 1898 and the following year in the Himalayas. In the former season they penetrated from Srinagar, which they had reached on their vehicles, into the mountains of Ladakh, Nubra, and Suru, and, later on, into Sikkim from Darjeeling. Next year they took with them Matthias Zurbriggen, who had been guide to Sir Martin Conway on his memorable journey in 1892, retracing his steps up the Biafo Glacier to the Hispar Pass, and then making some important ascents in the district about the Skoro La Pass. Altogether they were encamped for many days at altitudes not less than 16,000 feet, crossed several passes more than a thousand feet higher, and made the ascent of three virgin icy summits, rising to heights of 18,600, 19,450, and 21,000 feet respectively. Thus Mrs. Workman not only is the first of her sex to do serious mountain work in the Himalayas, but also has been higher than any of them above sea-level.

Climbing in the Himalayas, as the authors remark, is a much more serious affair than in the Alps. The glaciers and peaks, as shown by the excellent illustrations, one of which is appended by the courtesy of the publisher, are certainly not less difficult; roads are often wanting, mountain inns and chalets always; the camp

[1] "In the Ice World of Himalaya, among the Peaks and Passes of Ladakh, Nubra, Suru, and Baltistan." By Fanny Bullock Workman and William Hunter Workman, M.A., M.D. With three maps and sixty-seven illustrations. Pp. xvi + 204. (London: T. Fisher Unwin, 1900.)

must be pitched far away from even the smallest of towns; provisions, wraps, tents, all requisites, must be transported by human labour, which is costly and entails endless difficulties. The misdeeds of porters were once a stock subject of complaint among alpine climbers, but the worst of them are surpassed by Indian coolies, who are ill-fed, ill-clad and without mountain experience, while the native servants, almost universally, are adepts in cheating and mendacity. Through their misconduct one expedition, that into Sikkim, was a complete failure; and on this occasion the travellers apparently had good reason to complain of the British Political Officer at Darjeeling—not the one, it may be observed, whose courtesy Mr. D. Freshfield experienced on his tour round Kinchinjanga.

On the second year's journey they plunged more deeply into the Himalayan ice world. After reaching Askole by the Skoro La Pass, nearly 17,000 feet above sea-level, they ascended the Biafo glacier, which had shrunk and changed since 1892, to the Hispar Pass, from which they obtained splendid views of the neighbouring snowy giants, afterwards returning to Askole. Again leaving it they pitched a camp above the Skoro La Glacier, 16,200 feet from sea-level, at which, or a higher one, they remained for six days. From it they ascended the Siegfriedhorn, an excellent point of view 18,600 feet high, and the snowy Mount Bullock Workman, 19,450 feet. Returning over the Skoro La Pass they struck up the Shigar Valley, and finally, from a camp 17,900 feet above sea-level, reached, in unfavourable weather, the summit of Koser Gunge, about 21,000 feet.

The book is pleasantly written, though we cannot think such words as "itemized" and "motived" valuable additions to the English language. In addition to vivid descriptions of the scenery, it records, though professedly a work on mountain travel, some facts of scientific interest. The authors, like all recent travellers in the higher Himalayas, were struck with the signs of rapid disintegration. The great changes of temperature shatter the rocks, and strew the mountain flanks with fragments, forming huge slopes of débris and great alluvial fans. On one occasion they had a rather narrow escape when "a mixture of solid and semi-solid bodies," consisting of "mud and stones of every size, some of them many tons in weight, which were rolled on one another as if they were pebbles, poured down a glen, sweeping everything before it"—a mass twenty to thirty feet in height and some sixty yards in breadth. The work of mountain sculpture evidently proceeds more rapidly in the Himalayas than in the Alps. Yet there was probably a time when the latter passed through a similar stage. Mud glaciers, if the phrase be permitted, are not unknown in them, but much material, often hastily classed as moraine, is really of very composite origin, and is transported more by water than by ice.

The last chapter of the book, which gives a summary of their experiences of the effects of diminished atmospheric pressure, has a special value because Dr. Workman can speak as a medical expert. They lived for many days at heights between fourteen and seventeen thousand feet, sleeping several times in camps between sixteen and eighteen thousand feet, and thrice reached elevations between the last and twenty-one thousand feet. Their experiences agree generally with those of Whymper, Conway, FitzGerald and Vines. Below 15,000 feet Dr. Workman noticed no great departure from the normal. In the higher camps he slept well, though Mrs. Workman did not; they had good appetites, neither

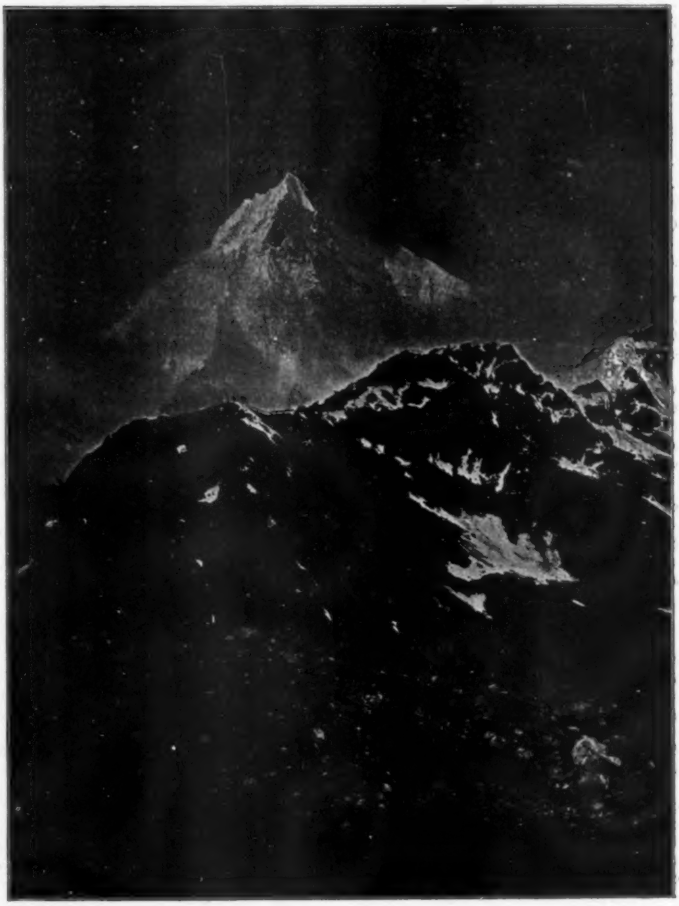

FIG. 1.—Siniolehum, Sikkim.

suffered from mountain sickness or, with one exception in each case, from headache, and this they attributed to cold rather than diminished atmospheric pressure; but both, like all their predecessors, felt the effects of the latter increasingly perceptible after rising above some 16,000 feet. They made slower progress, got more readily out of breath, and from about 18,000 feet upwards found that all movements, even stooping or altering the position when at rest, had to be made with deliberation—even holding the breath for a moment to take a snapshot with the camera was followed by gasping. But by accommodating themselves to the conditions they climbed without severe discomfort, and did not find that

this materially increased in the ascent to the highest point attained. The commissariat, in Dr. Workman's opinion, is a most important factor for success in reaching great elevations, since he holds dyspepsia and imperfect nutrition responsible for the distressing symptoms experienced by some of his predecessors. Food should be rather light, but nutritious. He makes some valuable remarks on the best kinds, stating that he thinks alcohol beneficial if it be taken in very moderate quantities and at meal times; warm wraps also are most important. In fact, his careful discussion of the subject is a valuable supplement to what has been already published, and proves that climbers anxious to reach the highest summits of Asia must possess either the *dura messorum ilia* or the purse which can bear the very heavy cost of a well-equipped expedition. T. G. BONNEY.

## THE ROYAL INDIAN ENGINEERING COLLEGE.

FROM letters which have been published recently in the *Times* and other journals, we have become aware of the following facts relating to the Royal Indian Engineering College, Coopers Hill:—

(1) The Secretary of State for India, acting on certain suggestions, made to him ostensibly by the Board of Visitors of the College, for remodelling the course of instruction on a very extensive scale, decided, some considerable time back, that it was necessary to dismiss *half the educational staff* of the College for the purpose of "reducing the present excessive cost of the staff and increasing the efficiency of the teaching."

(2) No hint that this momentous change was coming was conveyed to any of the seven gentlemen concerned, who received their first intimation on the 17th of last month from the President of the College, Colonel J. W. Ottley, in a letter of singular abruptness, heartlessness and irony. This letter, addressed to each of the seven gentlemen, was as follows:

"Sir, I have the honour to forward for your information a copy of a letter, P.W. 2531, dated 14th inst., from which you will see that I am instructed to convey to you the decision of the Secretary of State for India in Council that you will be required to vacate your appointment at this College at the end of the next Easter term.

"I have the honour to be, Sir, your obedient servant,
"JOHN W. OTTLEY, President, R.I.E.C."

The seven gentlemen to whom this communication was made are Mr. T. A. Hearson, M.Inst.C.E., Professor of Hydraulic Engineering, &c.; Mr. H. McLeod, F.R.S., Professor of Chemistry; Mr. W. N. Stocker, M.A., Professor of Physics; Mr. A. H. Heath, Assoc.M.Inst.C.E., Assistant Professor of Engineering; Mr. T. Shields, M.A., Demonstrator in Physics; Mr. P. Reilly, Demonstrator, Mechanical Laboratory; Mr. J. C. Hurst, Lecturer in Accounts.

With reference to the first of these facts we may affirm with confidence that the drastic changes—which involve serious curtailments of the branches of engineering and chemistry, and, apparently, the total abolition of physics and electrical engineering—are not to be attributed to the Board of Visitors. It is not credible that these gentlemen—very busy men as some of them are—can have devoted so much time and study to the educational course of the College as to justify their taking the responsibility of advising the Secretary of State for India to effect such extensive changes. We are compelled to adopt the conclusion that Colonel Ottley (whose name appears for the first time in the College Calendar for 1899-1900) himself is the real author. If this is so, we are further compelled to inquire into Colonel Ottley's qualifications as an educationist and a man of science. We are not acquainted with any scientific treatises or papers of his authorship, nor are we aware that he was selected as the head of a scientific college because of any experience as a lecturer on scientific subjects. His predecessors at the College have been, we believe, like himself, officers of Royal Engineers; but, apparently, they were wise enough to keep their theoretical autocracy as presidents within the limits prescribed by common sense.

From the memorial addressed by the dismissed members of the staff to the Secretary of State we infer that Colonel Ottley interprets his autocracy very literally, and is disposed to take no advice from the educational staff on matters of which they must necessarily know vastly more than he; and if so, it ought to be abundantly clear to the India Office that Coopers Hill College must be, as an educational institution, a complete failure.

It will be observed that the subjects which are most affected by the change—chemistry, physics and the mechanical laboratory—are those in which practical work has an important place; it is well known to those experienced in scientific education that this practical work is of the greatest value in developing in students the scientific spirit which is so essential to success in such a profession as engineering. We believe that the laboratories at Coopers Hill were enlarged some years ago and the staff increased, so that every student should have instruction in the chemical, physical and mechanical laboratories, on the recommendation of the Board of Visitors; but at that time one of the members of the Board was Sir William Siemens, who, knowing the result of practical work in the German universities upon industries and professions, considered its further development at Coopers Hill to be of importance. The present action appears to be in direct opposition to the former recommendations of the Board of Visitors.

Turning our attention next to the second of the above facts, we are compelled to express not only astonishment but indignation that such heartless brutality should have been possible in England. To know that seven gentlemen—two of them members of the Institution of Civil Engineers and another a Fellow of the Royal Society—are to receive a three months' notice of dismissal, timed, as it would seem, by the clock; to know that it must be of the utmost importance to them to be warned of the impending catastrophe so that they may have opportunities for seeking other work; and yet to keep their sentence a dead secret until the last available moment, constitutes a condition of mind which, we hope, is very rare among Englishmen.

The cause of Coopers Hill College is, in this matter, the cause of education at large. All that the dismissed members of the staff have asked from the India Office is that an independent committee of experts in scientific engineering, education, and college management should be appointed to inquire into the way in which the College is managed.

But we go beyond this request. We would make an appeal to men of science and of learning to make, either by deputation or by memorial, a representation to the India Office of the widespread feeling of disapproval with which this official action, for which the Secretary of State for India is responsible, is regarded, and of the desirability of ensuring to the educational staff of the College at Coopers Hill such influence in educational matters as is accorded in every College in the Kingdom.

## NOTES.

PROF. STRASBURGER has been elected a correspondant of the Paris Academy of Sciences, in the section of botany.

THE death is announced of Dr. Potain, professor of medicine in the University of Paris, and member of the section of medicine and surgery of the Paris Academy of Sciences.

IT is announced by *Science* that Prof. W. W. Campbell has been appointed director of the Lick Observatory, in succession to the late Prof. J. E. Keeler.

AT a special meeting of the Metropolitan District Railway Company on Monday, it was resolved that capital should be raised for the purpose of adapting the line to electric traction. This action has been forced upon the company by the diversion of traffic to the Central Electric Railway, and omnibus competition.

WE regret to announce the death of Dr. G. Pacher, of Padua University, on December 29, at the age of thirty-three. We owe to him some valuable studies of the records of the Vicentini microseismograph, and also the application of the pantagraph to that instrument.

THE Board of Trade have appointed a committee consisting of Lord Rayleigh, F.R.S., chairman, Sir John Wolfe-Barry, K.C.B., F.R.S., and Prof. Ewing, F.R.S., to consider to what

extent the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, and what alterations in the conditions of such working or in structure can be devised to remedy the same.

THE dispute between Kew Observatory and the London United Tramways Company still occupies public attention. Mr. R. T. Glazebrook, in a letter to the *Times*, gives an answer to the argument brought forward by the Tramways Company that the current leaking into their lines, presumably from the Central London Railway, should have already vitiated the magnetic observations made at Kew. He points out that the observations have not been appreciably affected, and that from theoretical considerations it was not to be expected that they would be. The disturbances that the London United Tramways Company are likely to produce will be about a hundred times as serious. Mr. Glazebrook has given a proof of this in a letter to the *Electrician*. A letter to the *Times* from Mr. Walter Hunter points out that the leakage currents from the tramway lines are a serious danger to gas and water pipes, and that the amount of harm done is merely a question of time. Perhaps it is too much to expect the Tramways Company to consider any but their own interests; it is to be hoped, however, that they will be brought to see that it is really to their own interest to insulate their return mains. There is no difficulty in doing so, and sooner or later it will have to be done. We notice that American experience shows that the only way to avoid electrolysis of the pipes is to keep the return currents out of the ground, and also that an experience from ten years running of over 200 miles of track shows that the double trolley system—which the London United Tramways Company consider impracticable—is cheaper in operation and maintenance than the single trolley system.

THE annual general meeting of the Royal Meteorological Society will be held on Wednesday, January 16, when the president, Dr. C. Theodore Williams, will deliver an address on "The Climate of Norway and its Factors."

THE *British Medical Journal* states that the Astley Cooper triennial prize of 300*l*. will be awarded for the best essay or treatise on "The Pathology of Carcinoma and the Distribution and Frequency of the Secondary Deposits corresponding to the Various Primary Growths." The essay, which is to be written in English, must reach Guy's Hospital, addressed to the physicians and surgeons, on or before January, 1904.

COL. A. T. FRASER sends us a copy of the *Indépendance Belge* to direct our attention to a matter brought before the last meeting of the Brussels Academy of Sciences. From the report we see that M. Charles Lagrange, director of the Royal Observatory, has resigned his office and has presented to the Academy his two years' arrears of salary, or a capital sum of ten thousand francs, to establish a prize to be awarded, at intervals of four years, for the best contribution to our knowledge of the physics of the globe. In expressing the thanks of the Academy for the gift, General Brialmont described the circumstances which led to M. Lagrange's resignation. It appears that for the past two years the position of director of the Observatory has been a humiliating one, because a young infantry officer without scientific attainments has controlled the establishment.

WE regret to announce the death of Mr. F. W. Egan, B.A., of the Geological Survey of Ireland, which took place at his residence in Dublin on January 6. After some experience as a civil engineer, he joined the Geological Survey under Jukes in 1868, and has ever since that date been actively engaged in the field-work of the service. For the last few years he devoted himself to the revision of the Silurian system in the east of Ireland, and separated the Lower from the Upper division over a large part of that region. Eighteen months ago, during a tour of inspection in County Wicklow, the Director-General of the Survey, with Messrs. Egan and McHenry, were thrown from an Irish car. Though each of the party sustained more or less injury, Mr. Egan fared worst. He had his shoulder dislocated, and suffered also some internal injury, so that he never regained his former strength, though he went through the field-campaign last year. Last week, symptoms of a grave kind began to show themselves, and he passed away on Sunday evening. Quiet, gentle and kindly, and not without a touch of humour, he was everywhere a favourite, and though he never had any ambition to distinguish himself, his long years of steady and patient devotion to his official duties enabled him to do good service to the cause of geology in Ireland.

THE Berlin correspondent of the *Times* announces that the German Emperor has conferred the Order of the Red Eagle, First Class, upon Lieutenant-General Count von Zeppelin, as a recognition of his efforts to overcome the difficulties of aërial navigation. The announcement of this distinction was made to Count von Zeppelin by the following letter from the Emperor, which was conveyed to him by General von Hahnke, the chief of the Emperor's Military Cabinet, before the beginning of a lecture upon the "Future of Aërial Navigation," delivered by the aëronaut at a meeting of the Berlin branch of the German Colonial Society:—"Having been informed of the ascents which have been made in the air-ship which you have invented, I am glad to express my appreciation of your persistence and trouble in successfully carrying out your self-imposed task, in spite of the manifold difficulties which it presented. The advantages of your system—the division of the long, extended balloon into compartments, the equal distribution of the burden by means of two independent engines, and a rudder working with success for the first time in a vertical direction—have enabled your air-ship to move with the greatest speed which has hitherto been attained and have rendered it amenable to the rudder. The results which you have achieved constitute an epoch-making step in advance in the construction of air-ships, and form a valuable basis for further experiments with the existing material. I will support you in these further experiments by placing the advice and the experience of the Balloon Division of the army at your disposal whenever you may desire. I have accordingly given orders to the Balloon Division to send an officer to be present at your future experiments whenever it may be of advantage. As an outward sign of my recognition I hereby confer upon you the Order of the Red Eagle, First Class."

THE annual general meeting of the Institution of Mechanical Engineers will be held on Friday evening, January 18, when the chair will be taken by the president, Sir William H. White, K.C.B., F.R.S. The first presentation by the Institution of the Willans Premium will be made to Capt. H. Riall Sankey; and the prizes awarded by the Council for the best two papers in the graduates section will be presented to Mr. W. B. Cleverly and Mr. Brees van Homan. The adjourned discussion will be resumed upon the paper on power-gas and large gas-engines for central stations, by Mr. Herbert A. Humphrey, read at the December meeting. At the graduates' meeting, to be held on Monday, January 14, Prof. J. A. Ewing, F.R.S. will deliver a lecture at the Institution on "The Structure of Metals," illustrated by lantern slides.

ENTOMOLOGY has sustained a serious loss in the death of Mr. John Henry Leech, which occurred on December 29, at the early age of thirty-eight. Mr. Leech, who had one residence at Hurdcott House, Salisbury, and a second at Kippure Manor, Kilbride, Dublin, was the eldest son of the late Mr. John Leech, of Gorse Hall, Cheshire, and was a graduate of Cambridge. In addition to being proprietor of the *Entomologist*, he was author of "The Butterflies of China, Japan and

Corea," a work for which he accumulated a large collection (part of which is now in the Natural History Museum) during his travels in the countries mentioned. If, as seems probable, his premature death was due to hardships and exposure during those travels, his name may be added to the list of martyrs in the cause of science. Mr. Leech was elected a fellow of the Zoological Society in 1885, and was likewise a fellow of the Linnean and the Royal Geographical Societies.

THE fall of two of the stones of the outer circle of Stonehenge, on the last evening of the nineteenth century, directs attention to the necessity for at once taking steps to preserve this remarkable prehistoric monument. The stones ought to be replaced while their original positions are clearly remembered, and before public interest in their fall has subsided. An engineer, writing to the *Times*, suggests a method of undermining the stones and imbedding them in a foundation of concrete or cement. A scheme of this kind would cost comparatively little, and there should be no difficulty in obtaining funds to carry it out. At any rate, the preservation of Stonehenge ought to be given serious consideration without delay, and archæologists should see that something is done to prevent the gradual collapse of this wonderful memorial of the past.

As already announced, a committee of the U.S. House of Representatives has decided to report in favour of the adoption of the metric system of weights and measures. Referring to this, the *Scientific American* makes the suggestion that England should join with the United States in introducing the system at the same time. Our contemporary remarks:—"The probability of the Bill's becoming a law would be greatly increased if the other great branch of the English-speaking race could be induced to make the change simultaneously with this country. The agitation in favour of the metric system is as strong, possibly stronger, in Great Britain as it is here, and in view of the close trade relations and the enormous volume of business between the two countries, it is well worth considering whether an attempt at concerted, or rather simultaneous, adoption of the metric system would not be advisable."

THE Brussels correspondent of the *Times* states that arrangements are in progress for a series of experiments in wireless telegraphy between Brussels and Antwerp, on the Guarini system. The apparatus for transmitting messages is nearly complete in both cities, and has been erected in Brussels in the Place du Congrès and at Antwerp on the tower of the well-known cathedral of Notre Dame. M. Guarini is doubtful whether local conditions will admit of direct communication, and he proposes to utilise Malines Cathedral, situated midway between the two cities, as an automatic repeating station. On the other hand, if it is found practicable, Antwerp itself will be made to serve as a repeating station for other points of the compass. The first trial is to take place on January 20.

DURING the past week the type of weather over the British Islands has entirely changed, the warm south-westerly current having given way to cold north-easterly winds, with high barometric pressure. During the latter part of last week the change of conditions caused a large amount of fog, especially over the southern parts of England, but this was quickly dispelled by a piercing N.E. gale which set in on Saturday evening, and was in turn followed by considerable falls of snow. The temperature was lowest over the midland and southern parts of the kingdom, where readings exceeding 10° below the freezing point have been recorded. This spell of wintry weather has spread over this country from the Continent, where conditions during the week have been abnormal. In Germany the thermometer has fallen below zero, and in France readings of 20° below the freezing point have been registered. Snow has fallen in many parts, and also in Rome for the first time during the last seven years. A rise of temperature occurred over the southern portion of England on Wednesday.

IN the U.S. *Monthly Weather Review* for September last, Mr. H. M. Watts discusses what he calls the Gulf Stream myth. He points out that the mild climate of north-western Europe is not due to the Gulf Stream, but to the prevailing eastward and north-eastward drift of the atmosphere which distributes over Europe the heat conserved by the whole Atlantic Ocean north of latitude 35° (roughly). The Gulf Stream is not distinguishable in temperature or "set," the author states, from the rest of the ocean, by the time it gets east of Newfoundland; and if it were by any possibility to be diverted at the Straits of Florida, no one in England would be a whit the wiser. If the drift of the aërial currents were reversed, the Atlantic Coast States, from North Carolina to Newfoundland, would have the mildness of Bermuda, not on account of any one ocean current, but because of the conserved warmth of the ocean as a whole. As it is, the August hot waves, the mild spells in January and February, and other anomalies which seem at times to reverse the seasons on the eastern coasts of the United States, are due, not to any shifting of the Gulf Stream, but to the intrusion of the anticyclone (or system of high barometric pressure) from the Atlantic Ocean.

WE have received the report of the Economical Society of Livonia, containing the results of the rainfall and air-temperature observations made at some 150 stations in the Russian Baltic provinces during the year 1899. The stations are maintained partly by the Central Physical Observatory of St. Petersburg and partly by the Ministry of Marine, and, to a considerable extent, the monthly and yearly results are included in the publications of the Central Observatory. The Society does good work in establishing a close network of stations, and in publishing the results in more detail than is generally done in the official year-books. The observations have been utilised during the time of harvest by the issue of special forecasts to agriculturists, and such a system is of great utility in endeavouring to discover the various anomalies that are found to exist in the distribution of rainfall, which cannot always be explained by the geographical conditions of the stations.

AN interesting contribution to our knowledge of the laws of vortex motion is given by Herr K. Żorawski in the *Bulletin* of the Cracow Academy, viii., 1900. The deduction of these laws from the equations of hydrodynamics, subject to certain physical assumptions, is mainly due to Helmholtz; the present paper deals with the converse problem of finding the mathematical conditions which must be satisfied by the velocity components in order that the so-called "circulation theorems" may hold good.

UNDER the title of "The transfigurations of a Science," Prof. Gino Loria has published a reprint of his academical address to the University of Genoa, dealing with the history of mathematics. It traces the gradual progress of mathematics from the ancient Greeks to the present day; the introduction of algebra into Europe, the fusion of the two branches of mathematics, algebra and geometry by the creation of analytical geometry; and, lastly, the rising up of the science of non-Euclidian geometry.

UNDER the name of "The Astronomical Demonstrator," Mr. W. H. Adams, of Wandsworth, has recently arranged a series of lecture-models intended to provide a teacher with the means of quickly illustrating, in a practical manner, most of the dispositions and phenomena of the solar system. A large sheet of cardboard or other material is provided with diagrams of the orbits of the planets, &c., and small models of the sun, earth,

moon and planets, with weighted bases and movable axes, are placed in their proper positions on their various orbits as determined from an ephemeris. In addition, there are various appendages capable of attachment to the objects for the illustration of special phenomena, such as eclipses of the sun and moon. The apparatus should be specially useful in classes where it is possible to allow the pupils to individually work exercises in the proper grouping of the planets, as in that way many of the definitions connected with orbital motion are presented in a very simple manner.

A VALUABLE contribution to the climatology of Africa appears in the *Mitteilungen aus den deutschen Schutzgebieten* in the form of records obtained from self-registering meteorological instruments in German East Africa. The period covered extends from the end of 1895 to the end of 1899, and the records, more or less complete in each case, are from the seven stations Dar-es-Salam, Tanga, Kwai, Tosamaganga, Tabora, Kibosho and Muansa.

THE *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains an important article on the question of glaciation in the Central Balkans by Prof. W. Götz. The author's investigations support the conclusions that (1) after diluvial deposits had been laid down in the mountain valleys, the erosive action of the streams greatly increased, probably on account of sinking of the lower courses; (2) the apparent indications of glacial action met with are false; and (3) traces of glacial phenomena are absent where they ought to be most marked, at the higher elevations in regions suited to the formation of snow-fields.

THE Oregon mountaineering club, which has adopted the title *Mazama*, the Indian name of the mountain goat, has just issued the first number of the second volume, or rather series, of its journal. The number is devoted to Mount Rainier, and includes an account of the expedition of the club to that mountain in 1897. Observations of the mercurial barometer, made at the summit by Prof. Edgar McClure, who lost his life by a fall during the descent, have been reduced by Prof. E. H. M'Allister, and give the height of Mount Rainier at 14,528 feet, compared with 14,519 feet obtained by the United States Geological Survey.

IN an article on the Phyllades of the Ardennes compared with the Slates of North Wales (Part ii. *Proc.* Liverpool Geol. Soc., 1900), Mr. T. Mellard Reade and Mr. P. Holland state their conclusions that slaty cleavage is not alone a mechanical effect, but that it is mainly due to a development of flaky minerals in conjunction with the shearing forces to which the slate rock has undoubtedly been subjected.

"THE Geology of the Country between Atherstone and Charnwood Forest" is the title of a geological survey memoir by Mr. C. Fox-Strangways, just published in explanation of the map No. 155. The pictorial frontispiece illustrates the Hanging Rocks at Woodhouse Eaves, one of those crags of sharply pointed rocks which characterise Charnwood Forest, and in some instances suggest resemblances to the kopjes of British South Africa. These ancient pre-Cambrian rocks have been studied in detail by Prof. W. W. Watts, who contributes a chapter on the subject confirming the main results attained by Prof. Bonney and the Rev. E. Hill, and adding much in the determination of an orderly succession. Mr. Strangways contributes chapters on the Stockingford Shales of Cambrian age, on the Coal-measures of parts of Warwickshire and Leicestershire, with illustrative sections and records of borings and sinkings, and on the newer deposits, Permian and Trias, Glacial and Recent. In an Appendix there is a list of works on the geology of Leicestershire, which has been compiled by Mr. Strangways with the aid of Mr. Whitaker.

To the *Proceedings* of the Philadelphia Academy (1900, pp. 568–581) Mr. H. A. Pilsbry has recently contributed a suggestive paper on the genesis of the faunas of the middle Pacific islands. The land mollusca of these islands form the basis of the discussion, which is formulated by the author in the following words:—"Are the Mid-Pacific snail faunas witnesses to the existence of a palæozoic or early mesozoic land mass, probably continental in proportions, and peopled by representatives of nearly all land-snail groups then existing?" A further question is whether this hypothetical continent was connected at a comparatively recent epoch with Chili. It is concluded that the evidence in favour of the existence of such a continent (upon the sunken heights of which the present island-masses, volcanic or coral, have been superimposed) is overwhelming. But both the marine and terrestrial molluscs lend no countenance that this continent was ever connected with America. It is somewhat curious that the author makes no reference to the Gondwána flora, which has been considered by Blanford and others as affording evidence of a girdle of land round much of the globe in low latitudes in palæozoic or mesozoic times.

THE fourth part of vol. lxviii. of the *Zeitschrift für wissenschaftliche Zoologie* contains an important paper by Herr Antonin Stolc on the power of assimilating and producing hydrocarbons by amœba-like organisms, such as *Pelomyxa palustris*. In spite of certain experiments that have had a negative result, the author is of opinion that such a power undoubtedly exists in the species mentioned, as well as in other members of the group, and he refers to the detection by Reinke and Rodewald of glycogen in the tissues of *Aethalium septicum*. To the same issue Herr W. Redikorzew contributes the results of his investigations into the structure of the ocelli of insects and other arthropods. The ocelli are originally formed by a depression in the thick hypodermal layer, in which one of two subsequent modes of development takes place.

PARTS x to xix of "Papers from the Harriman Alaska Expedition," all of which are devoted to the entomological results (including Arachnids), have been received. Mr. N. Banks deals with the Neuropteroid insects and Arachnida, Mr. H. G. Dyar with the Lepidoptera, Mr. O. Heidemann with the Heteroptera, Mr. T. Kincaid with the Sphegoids and Vespoids, while Mr. A. N. Caudell is responsible for the Orthoptera, Mr. T. Pergande for the Aphididæ and Formicidæ, and Mr. E. A. Schwarz for the Coleoptera and the Psyllidæ. The beetles are the group which had been most worked previously; only a single species of Orthoptera was obtained; but in most of the other groups a considerable number of new types were collected.

THE January number of the *Journal of Conchology* contains a list of British Marine Molluscs and Brachiopods, prepared by a committee of the Conchological Society. This is a good start for the new century, the nomenclature having been thoroughly revised and brought up to date. Some of the names, such as *Neptunea antiqua* for the red whelk, may be unfamiliar and strange, but it is to be hoped that in future they may, for the sake of uniformity, be adopted by all.

ADDITIONS to the British insect fauna continue to be made from time to time, the *Entomologist's Monthly Magazine* for January recording two kinds of saw-flies as new to our islands, while it also gives a list of species of beetles added to the list during 1899 and 1900.

REVIEWING the recent report on the working and results of the Woburn Experimental Fruit Farm, Dr. Maxwell Masters suggested (p. 178) that it would be an advantage to make a corresponding series of growths on poor soil, so as to afford a basis for comparison. We now learn that such a control station has been established already on a relatively barren soil; but the

installation is too recent to allow any definite inferences yet to be drawn.

MESSRS. W. N. BRUNTON AND SON, Musselburgh, N.B., have issued a new list of special brands of electrical resistance material. Taking the electrical resistance of copper as unity, the resistances of wires supplied by the firm are given as follows: Pure Swedish iron, 6; soft steel, 8; Edina steel, 12; German silver (19 per cent.), 17; German silver (28 per cent.), 26; Ferno, 30; and Beacon, 51.

MESSRS. CHAPMAN AND HALL have published a second edition, with appendix, of a book by Mr. F. Hovenden, bearing for its title the interrogations "What is Life? or Where are We? What are We? Whence did we come? and Whither do we Go?" Mr. Hovenden explains how he is able to answer these questions and revise the accepted opinions of men of science.

A SHORT account of the scientific work accomplished by the Tasmanian Society and the Royal Society of Tasmania, from the year 1840 to the close of 1900, has been prepared by Mr. Alex. Morton, the secretary of the latter society. The total number of scientific papers published by this society during the period mentioned, and not including small papers on various subjects, is 606. Of these no less than 132 are devoted to geology, palæontology and mineralogy, 85 to botany, 56 to astronomy and meteorology, and 53 to fishes. Mr. Morton's record is an interesting history of scientific activity in Tasmania, and it is a good testimonial to the valuable work of the Royal Society at Hobart.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from the Andaman Islands, presented by Lieut.-Colonel G. M. Prichard, I.S.C.; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. W. R. Fowler; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. E. Thomas; seven Verreaux's Guinea Fowls (*Guttera edouardi*) from East Africa, presented by Mr. J. F. Walker; two Crested Pigeons (*Ocyphaps lophotes*) from Australia, presented by Mr. W. L. Prentice; two Blue-winged Sivas (*Siva cyanoptera*), a Silver-eared Mesia (*Mesia argentauris*), a White-capped Redstart (*Chimarrhornis leucocephalus*), a Rufous-bellied Miltava (*Miltava sundara*), a Burmese Roller (*Coracias affinis*) from India, presented by Mr. E. W. Harper; three Painted Snipe (*Rostratula capensis*) from India, presented by Mr. Frank Finn; a Heron (*Ardea cinerea*) from South Africa, presented by Mr. J. E. Matcham; three Delalande's Lizards (*Nucras delalandi*), a Hispid Lizard (*Agama hispida*), a Three-streaked Skink (*Mabina trivittata*), a Rufescent Snake (*Leptodira hotambaeia*), a Lineated Snake (*Boodon lineatus*) from South Africa, presented by Mr. J. D. Waley; two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, three Viscachas (*Lagostomus trichodactylus*) from Buenos Ayres, three Open-bills (*Anastomus oscitans*), four Starred Tortoises (*Testudo elegans*) from India, a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Malacca, ten Small-scaled Mastigures (*Uromastix microlepis*) from Persia, a Common Toad (*Bufo vulgaris*), European, deposited.

## OUR ASTRONOMICAL COLUMN.

ELEMENTS OF COMET 1900 (*c*).—A circular from the Centralstelle at Kiel gives the elements of this comet, computed by H. Kreutz and J. Möller from observations on December 24, 26 and 28, 1900.

$$T = 1900 \text{ Dec. } 2{\cdot}660 \text{ M.T. Berlin.}$$

$$\left.\begin{aligned} \omega &= 178^\circ\ 0'{\cdot}8 \\ \Omega &= 192\ 28{\cdot}3 \\ i &= 30\ 25{\cdot}4 \end{aligned}\right\} 1900{\cdot}0$$

$$\log q = 9{\cdot}99184$$



The brightness of the comet is slowly decreasing. The latest observation recorded is by Aitken at Lick, the position being:—

$$\left.\begin{aligned} \text{R.A.} &= 23\text{h. } 23\text{m. } 18{\cdot}5\text{s.} \\ \text{Decl.} &= -23^\circ\ 7'\ 27'' \end{aligned}\right\} 1900 \text{ Dec. } 28.$$

*Ephemeris for 12h. Berlin Mean Time.*

| 1901. | R.A. h. m. s. | | Decl. ° ′ | | Br. |
|---|---|---|---|---|---|
| Jan. 10 | 0 36 30 | ... | −22 44·0 | ... | 0·68 |
| 11 | 41 51 | ... | 22 36·8 | | |
| 12 | 47 7 | ... | 22 28·9 | | |
| 13 | 52 20 | ... | 22 20·4 | ... | 0·60 |
| 14 | 0 57 29 | ... | 22 11·3 | | |
| 15 | 1 2 34 | ... | 22 1·6 | | |
| 16 | 7 36 | ... | 21 51·4 | | |
| 17 | 1 12 33 | ... | −21 40·6 | ... | 0·53 |

NEW VARIABLE STARS.—Three more variables have been recorded as discovered in 1900, bringing the number for the year up to twenty-three (*Astronomische Nachrichten*, Bd. 154, No. 3678).

21.1900, *Monocerotis*.—Prof. W. Ceraski, writing from Moscow, announces the variability of the star situated at

| R.A. h. m. s. | | Decl. ° ′ ″ | |
|---|---|---|---|
| 6 48 49·13 | ... | +11 25 37·0 | (1855·0) |
| 6 51 19·24 | ... | +11 22 21·6 | (1900.0) |

The brightness varies from 8·8 to 11·5 magnitude.

22.1900, *Cygni*.—Mr. A. Stanley Williams, from examination of photographs by Prof. Max Wolf and himself, has detected variability in the star B D. + 42°·3935, having the position

$$\left.\begin{aligned} \text{RA.} &= \phantom{+}20^{\text{h}}\ 54^{\text{m}}\ 45^{\text{s}}{\cdot}9 \\ \text{Decl.} &= +\ 42^\circ\ 2'{\cdot}0 \end{aligned}\right\} (1855{\cdot}0).$$

The magnitude varies from 9·5 to 11·0. A table of observations from 1891 is given, from which the following elements for the variable are determined:—

$$\text{Epoch of Max.} = 1900 \text{ Feb. } 5 + 13\text{d. } 315 \text{ E},$$

so that future maxima may be expected on Jan. 17 and 30, 1901. The writer draws attention to the fact that the rise from minimum to maximum is very rapid, a phenomenon previously recorded by Dr. Hartwig in the variable 2.1900 Cygni.

23.1900, *Andromedae*.—Dr. T. D. Anderson draws attention to the variability of the star B.D. + 38°·315, the place of which is

$$\left.\begin{aligned} \text{R.A.} &= \phantom{+}1^{\text{h}}\ 31^{\text{m}}\ 7^{\text{s}}{\cdot}9 \\ \text{Decl.} &= +\ 38^\circ\ 36'{\cdot}3 \end{aligned}\right\} (1855{\cdot}0).$$

The variation is from magnitude 9·8 (1900 Oct. 27) to 10·7 (1900 Dec. 15).

VISIBLE SPECTRUM OF NOVA AQUILÆ.—Prof. W. W. Campbell, during the autumn of 1900, made an examination of the spectrum of the new star in Aquila, which had been discovered by Mrs. Fleming in July, 1900. A 60° simple prism spectroscope was used in connection with the 36 inch Lick refractor. Prof. Campbell confirms the Harvard College observations as to the spectrum being nebular, but mentions differences between it and that of Nova Aurigæ in 1892 which are of importance. The visible spectrum is stated to consist of extremely faint continuous light in the green, and of three bright bands in the positions of the three nebular lines. The relative intensities of the three bands were in agreement with the corresponding intensities in actual nebular spectra. In addition, however, the bands were *not monochromatic*, but on the contrary were *very broad*, perhaps fully twice as broad as in the nebular spectrum of Nova Aurigæ in 1892.

NORMAL POSITIONS OF CERES.—Prof. G. W. Hill has collected the available observations of the minor planet Ceres for the past century during which it has been known, and formed normals from as many as were suitable. The computed normal positions are given for seventy-five years, the dates being for Greenwich mean noon, the values of the co-ordinates being *true*, not apparent. The planet has been observed at every opposition since its discovery, but on two occasions the reductions are discordant (*Astronomical Journal*, No. 487, vol. xxi., pp. 51–54).

## THE PANORAM KODAK.

EVER since the year 1845, when Friedrich v. Martens, a copper-plate engraver living in Paris, constructed a camera with a rotating lens and arrangements for a curved plate for taking panoramic views, this method of working has engaged the attention of photographers. Martens's apparatus was designed for Daguerreotype plates, but the convenience of flexible films for such work must very soon have been appreciated, for in 1850 we find Fox Talbot taking the trouble to state that one of his sensitive papers was particularly well adapted for the purpose.

M. Garella, in 1857, employed a flat plate moving tangentially to the required curved surface as the camera rotated, and so obviated the necessity for the curving of the sensitive surface. Messrs. J. R. Johnson and J. A. Harrison worked on similar lines when they produced their "pantascopic camera" in 1862, and its subsequent improvements. These and several other inventors suffered from the disadvantage of having to use glass plates which, whether flat or curved, were awkward to manipulate, and if curved were costly and especially troublesome. Still, very excellent work was done with these apparatuses.

Modern panoramic cameras date, practically speaking, from the commercial preparation of flexible or film-supported sensitive surfaces. Commandant Moessard, in 1893, employed a curved film supported in a curved celluloid holder, while M. J. Damoizeau (1891), in his "cyclographe," and Colonel R. W. Stewart, R.E. (1893), in his "panoram," employed films in the most compact way possible, drawing the film from one roller to another as the camera rotates. Colonel Stewart's camera is very small for the size of picture that it takes, and will, if required, photograph the whole horizon at one operation. He constructed his apparatus for Eastman's films.

But all these cameras were, comparatively speaking, costly, heavy and complicated, being actuated by clockwork or the equivalent, and the later examples were designed to be applicable to photographic surveying. No one appears to have considered it possible to construct a panoramic camera that should be light and simple in construction, and so available for the ordinary tourist, until the enterprising firm of Kodak, Ltd., introduced their "panoram kodak." In this camera they have not only succeeded to this extent, but have provided what is commonly understood as a "kodak"—that is, a camera that may easily be held in the hand during the exposure. Its construction is very ingenious in its simplicity. During exposure, the only moving part is the lens, which swings on a vertical axis, and the only motive power is a spring. The spring acts on a lever, and as the arrangement is laterally symmetrical, the exposure can be started from the side that the lens happens to be pointing towards. There is no shutter as ordinarily understood, the lens revolves through a half circle, and at each end of its journey is accommodated in a little recess that prevents any light passing through it to the inside of the camera.

The sensitive surface is the roller film, which passes over guides that maintain it at the correct curvature. The picture produced is seven inches long and 2¼ inches high, and the definition is good over its whole length, showing that the difficulty of the correct adjustment of the swinging lens has been quite satisfactorily overcome. As already stated, the apparatus is of the simplest kind. The lens works always at the same aperture. It has two rates of movement, the equivalent of two speeds of a shutter, effected simply by putting the full or a partial tension on the spring. But long exposures can be given by just repeating the ordinary exposure as often as necessary, the camera, of course, being firmly supported. We have seen some excellent views of dark wooded scenery taken in this way.

It may be worth while to remind those who think that they would appreciate the possibility of getting views including a wide horizontal angle, that the perspective of the pictures produced by all such apparatus as that referred to is cylindric, and, being different from the more usual plane perspective of flat plates, requires different precautions on the part of the photographer to avoid unpleasant results. The chief of these precautions is due to the fact that horizontal lines that lie either above or below the axis of the lens are curved towards the axis. The horizon itself is, of course, never curved on the photograph if the camera is level, and the panoram is provided with a spirit level as a guide for this purpose. Speaking practically, the one kind of view to avoid may be exemplified by a long building photographed from a point approximately opposite to its centre, facing it, say, from the other side of the street. It is impossible by any means to set a satisfactory representation of such an object from such a position, but the temptation to make the attempt is greater with a panoramic camera than with the more usual apparatus.

Now that a panoramic camera suitable for ordinary purposes has been shown to be possible, we hope that the construction adopted will be applied to the production of other sizes and perhaps other qualities of apparatus.

C. J.

## SOME RECENT ADVANCES IN BIOLOGICAL SCIENCE.[1]

A TIME-HONOURED distinction has been drawn between the so-called observational and the experimental sciences; and, pledged as we are to the former, we have to deal with those subjects which, in the hands of the immortal Darwin, have during the last forty years revolutionised all departments of science not wholly mathematical, for be it remembered that the formulation of the periodic law in chemistry is but that of an evolutionary hypothesis. So reactionary has been this influence upon thought and mental conduct, that it has rendered it impossible for us to think as did our forefathers, and has thereby increased our responsibility to our juniors and those who seek our guidance.

Never was progress more rapid than in these post-Darwinian days. Steady work in the discovery and classification of genera and species has proceeded all along the line, and with extending influence in the far East. Some idea of what is now taking place in our chosen field may be formed from the fact that, since the adoption of western methods by the Japanese, we have not only to record zoological discoveries of first-rate order, due to the fact that they alone possess the material upon which they are based, but to their lasting credit be it said that they have put us right on fundamentals upon which we have for generations imagined we knew all. To wit, a young Japanese, Hirota by name, alas, now dead! availing himself of the discovery by his teacher of a peculiar condition of the egg-membranes in the native tortoises, was led to argue that since these creatures and birds are not so very distantly related, the like might be forthcoming in them; and turning to the common chick—the bird most ready to hand—he succeeded in proving not only the existence of the condition suspected, but that we in the West, with our boasted methods and resources, by error of orientation, contenting ourselves with the mere examination of parts, instead of the whole object, have gone wrong on an elementary and most important detail.

One immediate effect of the demonstration of the truth o. evolution, now historically established, has been the substitution for the old-fashioned and merely tabular classifications of animate beings, of linear arrangements and phylogenetic trees. To those of the Hæckelian school, fired by an energy of enthusiasm, it appeared easy to locate every known creature to its proper place in the series; but while these persons did good by the stimulating influence of their work, it is needless to say that the hasty construction of such schemes must be fraught with error. So colossal a task is not to be achieved in a lifetime, and it too soon became evident that these fantastic expressions of supposed facts, like all classificatory formulæ, had to give way under the growth of knowledge, until now the time has come when our classifications of animals, which, be it said, are at best but the tentative expression of our ideas, are being based, not on the mere characters of the exterior, or of a single series of parts, but on the sum total of the maximum number of characters observable. Where we once thought we detected relationships, we now know we were often being misled, and the old-time supposition that mere community of structure is necessarily an index of community of origin has gone to the wall.

The past three decades will be ever memorable in the history of biology as that of what may be termed the embryological reaction, prompted by the thought that the clue to the origin of an animal in the remote past lies in the study of its development from the egg, believed to recapitulate the history of its race. Great, however, has been the disappointment in this respect, it having been discovered in many cases that the animate being,

[1] Abridged report of the Presidential Address, delivered by Prof. G. B. Howes, F.R.S., before the South-Eastern Union of Scientific Societies, at their Fifth Annual Congress, held in Brighton.

during its development, is so liable to adaptive change of but passing significance, that it becomes difficult to distinguish between this and the historic record originally believed to be passed through. But, that notwithstanding, upon data of this order many of our recent conceptions of the origin and succession of animal forms have been built up; and it is clear that if, on the basis of such facts, we attempt to deduce those generalised statements we term "laws," the test of our accuracy lies in appeal to the fossiliferous strata, in which we ought to find evidence of their presumed operation in the past. Here I am led to emphasise the importance of the study of palæontology, and, as bearing on the argument deduced from that of development, a striking outcome of recent palæontological investigation has been the unearthing, in the United States of America, of perfectly preserved remains of the Trilobites, the oldest and most primitive of all Crustacean forms. These creatures are now proved to have been possessed of but one pair of antennæ, there being two pairs present in every ordinary later member of the Crustacean class. It so happens, however, that this is the case for the adults only, and that the presence of but a single pair is characteristic of the larval stage through which all freely developed Crustacea pass, and, from what is now known of the details of the appendages of these Trilobites and the said Crustacean larvæ, there can be no doubt that in this particular class of animals the larva is realistic in its characters of the remote ancestor from which, in past ages, its members have been derived.

Other memorable instances have come to hand in the study of the palæontological record, which have profoundly modified our conceptions of the succession and primary relationships of animal forms. For example, evidence is now accumulating that in the case of birds the remote ancestors were of a more primitive reptilian stock than has been until recently supposed. Again, those structural features in respect to which the living Batrachia simplify the reptilian type are now coming to be recognised as largely due to retrogressive change, and we are beginning to see that both these classes of animals in all probability converge towards an assemblage of palæozoic forms, combining the characters of the two as to-day represented, and that the older naturalists, in classifying the cold-blooded terrestrial vertebrata together, were perhaps not so far out as we have been prone to think. A wonderful chapter has quite lately been added to the history of the horse, by the discovery in South America of an equine animal which possessed the single toe and other features familiar in it. The race to which it belonged has apparently become extinct only in quite recent times, and when we picture to ourselves the course of events to which it points, we conclude that in early Tertiary times the ancestors of the horse tribe, arising in Central America, migrated into the Old World, on one hand, and into South America on the other; and in each, by independent but parallel differentiation, gave rise to an essentially similar definitive form. Survival of this in the Old World alone has resulted in the horses of to-day, those now living in America having been secondarily imported by man.

The case in some respects recalls that of the pig tribe, except that, with this, migration in opposite directions has been accompanied by diversity of modification. Originating in early Tertiary times in Central North America, their ancestors migrated on one hand into the Old World, and by complication of their teeth gave rise to the swine and hogs of later times, while on the other hand, passing into the southern parts of America, they by numerical reduction of their teeth and toes gave rise to the peccaries of to-day.

Taken in conjunction with the now well-recognised fact that certain animals which in life and in all superficial features resemble each other can be proved on examination of more deeply-seated characters to be genetically distinct, this consideration raises the question of the importance of what is known in nature as the phenomenon of "Convergence." We now know of creatures externally almost indistinguishable from slugs which have the internal anatomy of snails and of slugs occurring independently in different parts of the world which exhibit a repetitional similarity of relationship to the snails of their respective areas; and we have long been familiar with a Crustacean—the "King Crab"—living on the opposite shores of the North Pacific, which, in respect to the segmentation of its body and the number and characters of its limbs more especially, conforms to the Scorpionid type. Numerous other instances might be cited, but these are sufficient, and the question for consideration is, how far such superficial resemblances, in that they have led to the association of forms in which they occur in a common classification, are trustworthy as criteria of affinity. The case for the King Crab and the Scorpion is one of long standing, and there is reason to believe it is still open to doubt. In all groups of Arthropods, to which both creatures belong, we meet with forms in which the familiar free body-rings or "segments" are for the greater part united, and others in which they are free, and there can be no doubt that the degree of union of these, which takes place in definite antero-posterior succession, is a sure index of "highness" and "lowness" in a given series—those in which few segments unite being low, those in which many unite, high. To this process of fusion of body-segments our American *confrères* apply the expressive term "cephalisation," and, when this test is applied to the two groups to which the animals in question belong, it is found that, in respect to it and certain correlated modifications, they each stand at the summit of their respective series—*i.e.*, that there are, among the "spiders," forms which, at least as regards cephalisation, simplify the Scorpionid type along lines parallel with those in which the so-called Eurypterids of the past, in this and other respects, simplify the King Crab type; and when, further, it is found that among the fossil Scorpions known there are indications of simplification of exactly the order the facts would lead us to suspect, it follows that King Crab and Scorpion of to-day each hark back to a distinct and independent assemblage of forms. With this, the association together of the culminating types, as in most of our current classifications, becomes dangerous, if not misleading; and we are brought to the realisation of the fact that mere community of adult structure does not necessarily imply community of origin, and that by a parallelism of modification two creatures of diverse ancestry, in adaptation to the conditions of life, may, independently, and by "convergence," assume a similar form.

The approximate resemblance between the crowns of the teeth of the horse and ox is a familiar example, and we have evidence that in this way certain types of teeth represented among the living mammals, by which these are still classified, have been anticipated by totally different groups in past periods of time; and if we are to trust recent research, teeth already modified along lines anticipatory of the carnivorous and herbivorous types of to-day co-existed in an assemblage of supposed cretaceous mammals of South America whose affinities are as yet not fully established.

The extent of the operation of "Convergence" in nature's work is but now becoming recognised, and there is proof to hand that many of our time-honoured classificatory systems are erroneous, by failure of its appreciation in the past. Impressed by this, it behoves us to reflect to what an extent nature's plans, so to speak, have, in the history of organic evolution, as in that of civilisation, repeated themselves, she being apparently intent on a recurrent diversity of differentiation, for some purpose associated with the balance of life we do not understand, as in the fact that when, in Mesozoic times, she had but the reptiles upon which to operate, she produced terrestrial, aquatic and flying forms, just as, in later periods, she has produced them with the mammals, which replaced these in order of time.

Again, with the development of the Darwinian doctrines, there early arose the realisation that, on the principle of descent with modification, the summary appearance of organs having no existence in near allies, either during the development of certain species or on the assumption of the adult state, presented a difficulty which even Darwin himself, ever more justly critical of his own work than many of his would-be opponents, clearly admitted. The independent appearance of luminous organs and those of electrical discharge in remotely related groups of fishes are ideal cases, at first sight calculated to break the back of the rigid Darwinian. Some thirteen years ago, Dr. Anton Dohrn, of Naples, and the late Prof. Kleinenberg, of Messina, formulated the doctrine of "Substitution of Organs," which provides that under varying conditions of life, and at different periods of development, sets of organs may replace others, to the better fulfilment of the life of the individual or race. To apply this to the case of the organs of electrical discharge in fishes in no way closely related, let it be said that our commonest rays and skates are possessed of such an organ, located in the tail. The peculiar feature of these fishes is the usurpation by their expanded side-fins of the propelling action, which, in ordinary fishes, is performed by the tail. What more

reasonable, therefore, when we know these rays and skates to have been derived from heavy-tailed shark-like ancestors with small side-fins, than the question how far conversion of the tail into an organ of electrical discharge may not have been the outcome of the taking-on by the side-fins of the swimming function? The answer to this is convincing and complete, for we find among the tropical and more distant allies of these rays, that the tail may become by elongation in one species a delicate trailing whip-lash; by abbreviation in another a mere vestigial stump, or by the addition of spines in yet another a formidable weapon of offence. Clearly, rid of the propelling function, it has become free to modify its ways, and the conversion into an organ of electrical discharge is found to be but one of a series of independent adaptations by "substitution."

Other and more beautiful examples of the working of this law might be cited, such, for example, as that of the provision for "casting" the tail, so well known among living lizards; but sufficient is before us to show in what manner the advance of knowledge dispels our difficulties, and that the stumbling-block of one generation may become the stepping-stone of the next.

If evolution—defined as the law of descent with modification, and involving the process of progressive advancement and passage with time from the simple to the more complex—is all sufficient to explain the existence and succession of the diverse forms of life, it might well appear that the conditions of modification are more complex and less regular than would have been expected; and we are, therefore, led to inquire in what the determining cause of modification and hereditary tendency may perchance consist. Looking back on the history of biology, three great names stand out above all others as those of the pioneers in its turning-points, Linné, Cuvier and Darwin. Linné taught us how to name and describe the objects in nature; Cuvier impressed upon us the fact that unity of structure underlies the great diversity in superficial form; Darwin, for the first time, furnished the clue to this unity, on the lines to which I have already referred, and showed us that vital phenomena are attributable to the working of a fixed set of laws.

It may be said of all living things that, so far as their bodies consist of a mass of living substance, which we term protoplasm, they are structurally identical. In seeking to classify them, be they plants or animals, the sharpest working distinction to be drawn is between those which consist of one structural unit or are unicellular, and those which consist of an aggregate of units or are multicellular—hence our terms Protozoa and Metazoa, Protophyta and Metaphyta, or collectively Monoplastids and Polyplastids, the term "plastid" being sometimes substituted for "cell." While the monoplastids, mostly though by no means all visible only under a lens, consist each of but one cell, one structural unit, of the order of those which in the aggregate compose the body of the polyplastid, there is no fundamental difference recognisable in the manner and extent to which multi- and uni-cellular beings stand related to the universe at large. Both are motile and sensitive; both produce waste, by processes which unchecked lead to decomposition and death; both stand, therefore, in need of recomposition and must be nourished; and both are loyal to the divine command to increase and multiply. It is concerning this reproductive process that the post-Darwinian period has witnessed an altogether unparalleled activity, in the attempt to get at the essence and to unravel the mystery of hereditary influence. The mental giant who has led the way is Prof. Weismann, of the University of Freiburg, in Breisgau. His whole series of doctrines find their focus in three epoch-marking addresses, which he delivered in 1881–1883 before the Association of German Naturalists and his University, entitled "On the Duration of Life," "On Heredity" and "On Life and Death." He took his stand upon the well-known fact that whereas reproduction of the unicellular organism is by a simple process of fission, the individual dividing into two without loss of substance, and becoming at once parent and offspring—in the multicellular organism the reproductive act involves only an insignificant portion of the body, and is sooner or later accompanied by the death of that which remains, and a consequent loss of substance. From this he argued that inasmuch as it is conceivable that the fissiparous process may go on indefinitely, the Protozoan of to-day may have arisen by repeated and prolonged fissiparous activity from that of long passed ages, and that the organism, never having suffered a loss of substance, may be immortal. Founding, in this way, his doctrine of the "Immortality of the Protozoa," he was led, by realisation that that portion of the body of the multicellular organism which fulfils the reproductive function passes to its share in the formation of a new individual a living element, to distinguish between it, the "germ-plasma" which never dies, and the rest of the body or "somatoplasma," which is lost by decomposition and death, and he in this way sought to extend the conception of immortality to the reproductive elements of the higher organisms.

This marvellous generalisation—prettier far than poetry—created in the early "nineties" a veritable furore; and it furnishes us with material for reflection and mental consideration of an altogether unique order. So profound, however, was its effect upon contemporary science and thought, that under its influence there arose a horde of eager investigators, intent on its development and the search for the seat of primary hereditary influence. The literature and vexed controversies which have in consequence arisen are now voluminous, and Weismann and his followers, eager to push forward, have pressed theory upon theory, often with contradictory effect. His whole series of observations, however, focus in the afore-named great generalisation, and, as for alleged contradiction, I can only regard it as due to the influence of his friends, who, eager for his advance, and perhaps, in the case of some, for association with his work, forced him to extremes which he would never have contemplated had he been left alone.

As might be supposed, the conception of the immortality of protoplasm has not passed unchallenged. Maupas, an acute French investigator, has discovered of the familiar "Bell Animalcules," that prolonged fissiparous reproduction is accompanied by progressive diminution in stature, leadin , if unchecked, to senility and decay; and, having determined by observation the number of generations in which this veritable extinction may be brought about, he has succeeded in proving that, by means of a conjugative process, involving a blending of two individuals, its effects are overcome. To what this remarkable discovery may ultimately lead we know not, but it so happens that, whether the conception of immortality be right or wrong, it arose in the minds of trained naturalists long before Weismann's time. He himself starts with a quotation from Johannes Müller, the founder of comparative anatomy, to the effect that "organic bodies are perishable, and that, while life maintains the appearance of immortality, in the constant succession of similar individuals, the individuals themselves pass away." And similarly, R. Owen, in two great lectures on "Parthenogenesis," delivered before the Royal College of Surgeons, in 1849, came nearer the mark, with the astounding paragraphs:—

"Not all the progeny of the primary germ-cell are required for the formation of the body of all animals; certain of the derivative germ-cells may remain unchanged, and become included in that body which has been composed of their metamorphosed and diversely combined or confluent brethren. So included, any derivative germ-cell . . . . may commence and repeat the same processes of growth and imbibition, and of propagation by spontaneous fission, as those to which itself owed its origin, followed by metamorphoses and combinations of the germ-masses so produced, which concur to the development of another individual, and this may be, or may not be, like that individual in which the secondary germ-cell or germ-mass was included."

And, concerning the conception of immortality of the Protozoa, he also wrote:—

"It is by no means easy to find a name for the relation in which the fissiparous monad stands to the two monads between which it has been equally divided. A parent retains its individuality distinct from its progeny; but the monad has become a part, and indeed the chief part, of the two that have resulted from its spontaneous fission. Both separate moieties are, in an equal degree, the same individual as the whole from which they proceeded; and in an infinitesimal, though conceivable, degree, the actual monad is the same individual as the first created one, from which it may have proceeded by an uninterrupted succession of spontaneous fissions, and in that degree it may be viewed as one of the oldest known individuals in creation, the individual being never wholly or in part deceased."

Not that this in any way detracts from the merits of Weismann's labours! On the contrary, to him is due the credit of having put the vitally important topic which now concerns us on a scientifically sound and workable basis—an achievement of which he may well be proud.

It being evident that the unicellular and multicellular organisms stand alike responsible to the universe at large concerning

their functional activities, we are led to inquire in what way the localisation of these in the higher and compound forms may have come about. "Differentiation of labour" is the popular explanation, and one is prone to ask whether the structural or the functional differentiation was first achieved. It has generally been taught in the past that the structural preceded the functional, but we are now coming to doubt this long-cherished conclusion, in evidence of the fact that nature will, with equal facility, effect corresponding differentiation for the fulfilment of the same end, in either the whole body of a unicellular organism or a localised part of a multicellular one—in either a single cell or a cell-aggregate—as, for example, in the formation of what are known as the ciliated membranellæ of the Infusor *Stentor*, and the so-called corner-cells of the Mollusc *Cyclas*. Differentiation depends, not on the interaction of cells, but upon the elementary structure and potentialities of protoplasm, or, as Prof. C. O. Whitman, of Chicago, has expressed it, "organism precedes cell-formation."

If this be so, there is raised the question how far the idea, developed during the past two decades, that the animate being is a mere blind automaton, and its actions but complicated functions of a chemico-physical order such as we deduce from the study of the inanimate, is correct, and we are prone to inquire if the structural units of the animal body are, so to speak, bricks set to a mathematical relationship, controlled by laws of pressure, or living units, capable of working to their own ends, and defying mechanical conditions such as apply to the inanimate.

It has long been said of us devotees to the observational branches of science that our methods are inaccurate by lack of qualitative treatment, and the distinction has been drawn between ours, the so-called "inexact," and the mathematical or "exact" sciences. On this basis there are now being pushed forward attempts to apply statistical, experimental and mathematical tests to the study of vital phenomena. All honour to those who are making them, for it is certain there are phases of life capable of mathematical treatment, but the mystery of life can never be thus solved; and, concerning the objection to the observational method, I would remark that if by that we are to understand observation, with confirmation and generalisation, and rejection of the non-confirmable, our non-mathematical procedure is scientific. Huxley has long ago said of mathematics that what you get out of the machine depends entirely upon what you put into it.

Ten years ago, any one asked to define the nature of the primitive organism from which all organic beings are descended, having regard to then known chemical phenomena of life, would most certainly have argued in favour of a green-plant, or of some organism capable of decomposing $CO_2$ under the action of sunlight, and of raising inorganic substances to an organic level, thereby rendering them fit for animal food. We now know of the existence of lowly organisms capable of decomposing $CO_2$ in the absence of chlorophyll. The ploughing in of the roots of certain leguminous plants, in which our German cousins have been for years ahead of us, is now well known to be associated with the presence of fungi, capable of assimilating the nitrogen of the soil. In the nitrifying bacteria, we are now familiar with organisms by whose aid ammonia becomes the origin of nitrates and nitrites, and there are others which, by a process of denitrification, effect the reduction of these, with liberation of free nitrogen. And startling indeed is the knowledge that there exist in certain seas, and, it may be, near our very doors, bacteria which possess the marvellous power of decomposing sulphates, and of living in an atmosphere of sulphuretted hydrogen. The discovery that certain lowly fungi are so sensitive to chemical change in their nutritive media, that the presence of one part in 50,000 of zinc chloride will act as a powerful stimulus, and produce a growth some 700 times its own initial weight, and that one part in 1,600,000 of silver nitrate is abruptly fatal to it, is simply astounding.

Turning to the animal, we find that whereas in the case of the hot-blooded rabbit the weight of oxygen per hour sufficient for the maintenance of life is as 2·284, in the case of the cold-blooded American turtle it falls to 0·088. With the animal, as with the plant, so sensitive are the parts of the body to variation in chemical composition of fluids with which they may be brought into contact, that, under conditions of experiment, it has been found that the heart of a frog, of which the beat has been lessened or arrested by treatment with salt-solution or distilled water, may be revived by the accession of one part in 10,000 of calcium carbonate.

What all this means, regarding the processes involved in the mystery of life, and in what direction it is leading us, the future can alone sufficiently show. One thing is certain, that since living matter in all its forms is constantly undergoing waste and disintegration by oxidation, life is possible only under a penalty of death, and we are prone to inquire if this is a mere chance circumstance or a necessity to some beneficent end. We know that in the order of evolution the simpler forms of plants and animals have, by combination and advancement, given rise to the more complex, and it is clear that if this process were to go on indefinitely, a time might come at which all the simpler forms would be used up, and life would cease. The breaking up of the complex forms and the dissociation of their elements, however, results in the return to mother earth of the raw material of which they are composed, and thereby renders possible the repetition of the cycle, and from this it follows that the destruction of the individual may have been really a necessity, in order that others might live.

In this consideration we are once more brought into touch with inorganic nature, and it is a remarkable fact that the very chemical elements which enter into the composition of the simplest protoplasmic structures are precisely those contributing to the formation of the simplest of chemical substances, so far, at any rate, as hydrogen, oxygen, nitrogen, sodium, calcium, magnesium and iron are concerned. My friend and colleague, Sir Norman Lockyer, has recently emphasised this consideration, and, with a boldness worthy his great reputation, has dared to discuss the significance of the facts. The spectroscopic analysis of the hotter stars has revealed to him the truth that their simple chemical constitution is explained by the fact that the final products of dissociation by heat are the earliest chemical forms. From this he deduces the conclusion that with the heavenly bodies, as with the organic world, the simplest forms appeared first, and that the dissociation stages of the former, as of the latter, reveal to us the forms the coming] together of which has produced the thing dissociated or broken up. Passing from the hottest to the cooler stars, he argues that, like the various geologic strata, these bring before us a progression of new forms of increasing complexity in an organised sequence, and, developing this pregnant line of thought, he reverts to the uniform simplicity in chemical constitution of the earliest inorganic and the primitive organic forms, and deduces the belief that "the first organic life was an interaction, somehow or other, between the undoubted earliest chemical forms." It is a far cry from the primitive monad to the hottest star, but so convinced is Sir Norman Lockyer of the analogy between the methods of organic and inorganic evolution, that he has used the latter term as the title of his book, which I can strongly recommend to your earnest consideration. We advance by facts, we live by ideas, and if Sir Norman Lockyer's fascinating theory does no more than set the trained mind to work and arouse interest in the topics with which it deals, it will have served its purpose.

To turn now to the physical properties of living matter. Concerning the eye, it may be said that in the contraction of its retinal pigment by a vital act in definite response to the rays of the spectrum, and in the falling to a focus, within the substance of the crystalline lens, of the inverted image formed by that, it is neither constructed nor behaving in the manner of the inanimate photographer's camera, with which it has been *ad nauseam* compared! Again, the discovery in recent years that whereas, during life, the gaseous diffusion of respiration does not take place in strict conformity with the laws applying to inanimate membranes, it does so after death, with that of the changes and processes undergone by the food in its passage through the intestinal wall, now proved to be of no mere mechanical order, testify to the conclusion that the moment you bring the conditions and arguments deduced from the study of the inanimate to bear upon what may be expressively termed the animate organic membrane, they either do not apply or are set at defiance.

Many other examples might be cited. We are getting back to a conception of a "vital force," not of the order of the ancients—a "Psyche"—a mysterious controlling influence beyond our ken, but one which we may term a *Neo-Vitalism*, which teaches us that although organic matter is in its manifestations chemical and physical and the basis of life is associated with chemical and physical processes, the physics and chemistry are not those of the inanimate as at present understood, and gives us hope of its discovery if we will but persevere.

Finally, as to the charge of inexactitude. It is one of the

blessed aspects of the study of animate nature that there may be the alternative interpretation. Work at a problem long as you will, you will find that when you flatter yourself you have obtained the clue to its significance it will often happen that it is just that which you have missed.

Call it ambiguity if you will; it is primarily due to the structural and functional complexity of living matter, and there lies in it, to my mind, the greatest charm of our science, in that it appeals to the imagination, and therein arouses one of the highest of the intellectual faculties. We work in hope, content to investigate the reason of phenomena, but the nature of things will be ever beyond our grasp.

As contributing to the advancement of knowledge, and to a fuller understanding of the phenomena which underlie the operations of nature, the topics to which I have drawn attention are among the most important in the recent progress of science —the most revolutionary results of patient, persistent inquiry. In their definitive form, the so-called "laws of nature" are but generalised statements of fact, and, so far as we are individually concerned, I would remind you that, since we are but members of the great animal subkingdom, dependent, with the probable millions of species which compose it, upon a common set of conditions in our relations to the universe at large, it is impossible, if we would know and appreciate our position in the world, to present a deaf ear to their teaching. It behoves us not only to ponder them on our own account, but to see to it that, as time progresses, those committed to our charge are so brought up as to be not wholly ignorant of them.

And this brings me to the concluding portion of my address.

As members of local committees and scientific societies, we are pledged to the task of what is known as popular education, and its correlate the "popularisation of science." Exactly what this hackneyed expression may be taken to imply I have never yet discovered, and, speaking for myself, I regard it as erroneous. Science cannot be popularised, and any work to-day worthy the name of scientific must be technical. To popularise science is an impossibility, but to popularise the results of it is quite another thing.

Our task is educational, and we have to encourage a love of those subjects which form the basis of the doctrine of "organic evolution," from which has arisen the greatest revolution in thought and the conduct of life the world has ever seen. How heavy the responsibility we thus incur! How poor the encouragement we, for the most part, receive at the hands of our fellow citizens! To the credit of our nation, be it said, the State is now alive to its responsibility in the matter, and to that of our County Councils, that they are doing their duty towards the higher education and science in particular. But I have grave doubts if the best is being done by private enterprise, which in all matters of progress is a characteristically British method of procedure in the higher walks of life. How many of us, competent to aid in the local management and organisation of museums and scientific institutes, are doing all that we might to keep those in charge of them on the right path. One still finds exhibited the *omnium gatherum* of scraps, the product of nature overshadowed by the artifice of man. In place of the representative collection of objects of local interest, of specimens and maps which should furnish a key to the physical constitution of the neighbourhood, and which a visitor has a right to expect on entering a strange land, one too often finds the rumble-jumble of odds and ends, with here and there a hidden treasure. There is a so-called "museum" not many miles from this place, in which payment is extracted from the visitor to behold, as a conspicuous exhibit amidst a collection of oddments, a milk tin recovered from the *Fram*, which Nansen would himself probably disown! Local control and organisation should render this sort of thing impossible, despite its being due to "private enterprise," and you must please pardon me when I draw attention to the fact that we in the south are behind our northern brethren in respect to local organisation for science and the higher education. I can conceive no better outcome of this meeting than that we should at once resolve, by connected action, to put this right.

On appeal to a frivolous public, we are told there is nothing to come of it, that work of the kind to which we aspire is not remunerative, and that the cultivation of scientific tastes is to be avoided, as narrowing in effect and tending to dwarf the religious instinct, and foster doubt. To this I would reply (1) that most of our boasted advantages in civilisation have been due to the outcome and the application of science to daily life and domestic use; (2) that there is no better tonic for the human mind than that afforded by perusal of the works of nature; (3) that the existence of matter, "motion, and law-abiding operation in nature, are greater miracles than were ever recounted by the mythologies"; and (4) that science, with love, now rules the world.

To counteract the tendency of our time, it is for us to see to it that the selection and arrangement of the exhibits in our museum collections shall furnish the visitor with a series of local object lessons, both attractive and instructive, and so ordained as to create in the mind of the mere passer-by—as can readily be done by the excellent system of descriptive labelling now coming into vogue—a desire to know more of his immediate surroundings, and, through them, of his position and relationships as a dweller in the neighbourhood and a factor in the universe at large.

The aim and object of not a few of our local scientific societies would seem to be publication rather than this, and against the tendency I would urge every influence I can command. If confined to mere local records of fact, *Proceedings* or other publications, maintained in moderation, are well and good, but, with larger and central institutions given to the meeting of persons from various localities for comparison of local forms and discussion of broad principles, the local society, in striving after this, is exceeding the bounds of reasonable distribution of labour.

Once again let me remark that we can have no higher object in view than the capture of youth. Huxley has wisely said:—

"The great end of life is not knowledge, but action. A small percentage of the population is born with special aptitude of some sort or another; and the most important object of all educational schemes is to catch these exceptional people, and turn them to account for the good of society . . . and to put them into the position in which they can do the work for which they are specially fitted."

And he added:—

"That if the nation could purchase a potential Watt, a Davy, or Faraday, at the cost of 100,000*l.* down, he would be cheap at the money."

To me nothing would be more gratifying than that there might result from this meeting an agreement upon a line of action which might track a genius and place him on the ladder he was born to ascend, to the permanent glory of his race and benefit of the world at large.

In these days, when bombast and self-assertiveness are apt to be mistaken for executive power, we want all the originality we can secure. Learning is but our knowledge of the experience of others, knowledge our very own! Higher ambition than that of adding to the sum of knowledge no man can have; wealth, influence, position, all fade before it, but we must die for it if our work is to live after us.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A COURSE of lectures and demonstrations in practical hygiene for teachers will be held partly at Bedford College and partly at the Sanitary Institute, on Saturday mornings during the three terms of the present year.

WE learn from *Science* that Mr. John D. Rockefeller has made a further gift of 1,500,000 dollars to the University of Chicago. Of this sum, 1,000,000 dollars is to be used as an endowment fund. The balance of the gift is to be used for general needs. Mr. Rockefeller suggests that 100,000 dollars be used for the construction of a university press building. Mr. Leon Mandel has given 25,000 dollars to the University, in addition to his previous gifts.

ONE of the most important developments recorded in the recent report of the Somerset County Education Committee is the presentation, by Lord Portman, of an experimental farm, five miles from Taunton. The farm consists of 142 acres, of which 80 are pasture. Lord Portman has made considerable alterations and additions to the farm buildings in order to bring them up to date and to adapt them to the requirements of the County Committee. The primary object of the farm will be experiments on the profitable feeding of farm animals of various

kinds. Incidentally there will be considerable opportunity for experiments in the improvement of land and the best methods of growing various crops.

ANNOUNCEMENT is made in the *British Medical Journal* that the rich family of Mitsui of Tokio has offered an extensive site in that city for the erection of a University for women, and three other citizens have between them contributed a sum of 24,000*l.* for the cost of the necessary buildings. The work is already in progress, and it is hoped that the new University will be opened in the spring of 1901. It is not likely that there will be any want of students, as in recent years very many young ladies of good family have applied to be admitted to the University courses, especially to the faculty of medicine and the Polytechnic School. The latter institution is intended for the training of civil engineers, a circumstance which seems to show that Japan is about to set an example to Europe in opening up a new sphere of labour for the women of the future.

THE new Calendar of University College, London, announces several developments for the present year. There will be a course of work in experimental psychology, and an elementary course of physiological demonstrations on the nervous system and the sense-organs. A complete installation for the production of liquid air has recently been presented to the College, and facilities are offered for research at low temperatures. Instruction is given in spectroscopy, which forms a subdepartment to chemistry, and is equipped for practical work in spectrum analysis and spectrum photography. A special course on the morphology of the Sporangium has been arranged, and sub-departments in physiological chemistry and histology have been established. The Calendar contains an important speech delivered by Lord Reay, president of the College, on the development of the University of London; and lists of original publications by members of the Faculties of Arts, Laws and of Science.

## SCIENTIFIC SERIAL.

*American Journal of Science*, December, 1900.—Torsional magneto-striction in strong transverse fields, by C. Barus. The effect of longitudinal magnetisation is an increment of rigidity in all paramagnetic metals, whereas the permanent effect of a transverse or a circular field is relatively inappreciable so far as rigidity is concerned.—Notes on tellurides from Colorado, by C. Palache. The minerals described include sylvanite from Cripple Creek and two well-developed Hessite crystals from Boulder County.—New species of *Merycochoerus* in Montana, by Earl Douglass. The new species is called *Merycochoerus laticeps*. It has a low skull, broad behind the orbits, and narrowing rapidly towards the front and back. Brain case short, the length behind the post-frontal process being about one-half the distance in front of it. Premaxillaries united in front, forming a trough-shaped depression, evidently for the accommodation of a proboscis. Maxillaries deeply concave on the sides of the face. This, with the malo-maxillary ridge, which widens outward rapidly towards the zygomatic arch, forms a broad and nearly horizontal shelf above the posterior premolars and anterior molars.—Mohawkite, stibio-domeykite, domeykite, algodonite, and some artificial copper arsenides, by G. A. Koenig. In the Keeweenaw copper formation, the arsenides are not found in the bedded deposits of native copper, but always in fissures, intersecting the beds. The veins have thus far only been observed in the lower beds, near the foot of the formation to the south-east. Arsenic, however, is found in the smelted and refined copper of all the mines. The author describes the physical and chemical constitution of the minerals named.—Heat of solution of resorcinol in ethyl alcohol, by C. L. Speyers and C. R. Rosell. Since heat is rejected when resorcinol dissolves in a large excess of ethyl alcohol, and since heat is absorbed when it dissolves in a small quantity, the temperature should not change when these substances are mixed in some certain proportion. This proportion is found to be about six grammes of resorcinol to about 100 grams of ethyl alcohol.—The sulphocyanides of copper and silver in gravimetric analysis, by R. G. van Name. The estimation of sulphocyanides by precipitation with silver nitrate and direct weighing of the precipitate is wholly permissible. The method is extremely simple, and the results are quite accurate.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, December 6, 1900.—"On the 'Blaze Currents' of the Frog's Eyeball." By Dr. A. D. Waller, F.R.S.

The author demonstrated by experiment on the frog's eyeball the responses to electrical stimuli, which he terms "blaze currents." He gave an account of his work, which is briefly summarised in the following statements. The normal electrical response to light and to every kind of stimuli is positive, *i.e.*, from fundus to cornea; it is partly retinal, partly by other tissues, it is reversed by pressure. "Blaze currents" are responses to electrical stimuli, and are comparable with the normal discharge of an electrical organ amounting to 0·03 volt. "Blaze currents" manifest summation of stimuli and effects, staircase increase and fatigue decline. The energy of a blaze effect may considerably exceed the energy of the exciting cause. An eyeball will show blaze currents during five days after excision, they diminish under prolonged illumination, and increase under prolonged darkness. The influence of increased temperature and pressure is studied, and under the latter four types of response are recorded.

If single electrical currents are passed through a normal eyeball and a galvanometer in a homodrome and in a heterodrome direction, *i.e.*, with and against the direction of normal discharge, the homodrome (positive) deflection is greater than the heterodrome (negative) deflection.

### EDINBURGH.

**Royal Society**, December 3, 1900.—The Rev. Prof. Duns in the chair.—Dr. R. J. A. Berry read a paper on the true cæcal apex, or the vermiform appendix—its minute and comparative anatomy. The object of the microscopical investigation was to see what, if any, analogies exist between the true apex of the cæcum in the lower animals and its equivalent, the vermiform appendage, in man. Three types were selected, the rabbit, the cat and the pigeon; and in these there is a marked accumulation of lymphoid tissue at the true cæcal apex, the accumulation reaching its maximum development within a week after birth. These developments were illustrated by numerous lantern slides; and from them, combined with a comparison of the corresponding arrangements in other animals, it was concluded that lymphoid tissue is the characteristic feature of the cæcal apex, the vermiform appendix in man being represented in the vertebrate kingdom by a mass of lymphoid tissue, situated most frequently at the cæcal apex; that, as the vertebral scale is ascended, this lymphoid tissue tends to be collected into a specially differentiated portion of the intestinal canal—the vermiform appendix; and that this appendix in man is not, therefore, a vestigial structure, but is a specialised part of the alimentary canal. Dr. Thomas Muir communicated two papers, (1) Some identities connected with alternates and with elliptic functions; (2) A peculiar set of linear equations, the latter being an interesting case of bi-rational transformation.

Dec. 17.—Lord Kelvin, President, in the chair.—The chairman made a communication on the transmission of force, the main conclusions being that the æther itself could not be subject to gravitation, the supposition involving instability, and that although electric and magnetic force could be explained mechanically in terms of points which acted as sources and sinks of æther flow, no explanation had hitherto been given of gravitational force. We seemed to be compelled to fall back upon the simple assumption that gravitational action was an inseparable attribute of the atoms of matter, that it was a fundamental fact behind which it was impossible to get. Mr. C. Tweedie, M.A., in a note on Dr. Muir's paper on a peculiar set of linear equations, read at last meeting, gave a simpler demonstration of a general theorem suggested in that paper. Prof. J. T. Morrison (Stellenbosch) communicated a paper (date Nov. 6) on a suggested solar oscillation, with some of its possible astronomical and meteorological consequences; together with a generalisation as to the constitution of matter and the cause of gravitation. The sun was supposed to be subject to a pulsation of twenty-two years' period with reference to an axis nearly coincident with the axis of rotation; and on this assumption, for which cosmical causes might be plausibly suggested, the sun-spots occurring in the regions of greatest surface displacement received a ready explanation. Variations of temperature accompanying the expansion and contraction of the sun would produce a corresponding periodicity in the vertical projection of

material from the sun, giving rise to the streamers. These, acting on the lighter materials of approaching and receding comets, would tend to form the tails pointing in the well-known manner. Electrons would be projected in great quantity along with the streamers, and would, when they reached the earth, have obvious effects upon terrestrial magnetism. These effects would occur about a year after the outburst on the sun which projected the electrons producing the effects. The second part of the paper was very speculative, and aimed at showing that gravitation and electric force were fundamentally the same. A fuller presentation of this theory was promised in a future paper.

PARIS.

**Academy of Sciences**, Dec. 31, 1900.—M. Maurice Lévy in the chair.—Revision of the arc of meridian of Quito, by General Bassot. The necessary funds having been voted by the French Government, the plan of operations proposed is sketched out, and the names of the surveying party given. It is proposed to measure about six degrees of arc, and the operations, which will be commenced about June 1901, will probably take four years. A committee of the Academy, consisting of MM. Faye, H. Poincaré, Hatt, Bassot and Lœwy, was appointed to control the operations of the mission.—Rectification of an analytical datum relating to the amount of hydrogen disengaged from granites by acids, by M. Armand Gautier. In a note previously published upon this subject, the amount of hydrogen given was too large, as it has been found that the powder was contaminated with some iron introduced accidentally during the process of powdering.—On the differentiation of the vascular tissues of the leaf and stem, by M. Gaston Bonnier. An examination of the origin of the vascular meristem in the leaf, and a comparison of its differentiation with that of the analogous tissues occurring in the stem. The paper is accompanied by eight illustrations.—M. Dedekind was elected a correspondent for the section of geometry, and Prof. Strasburger a correspondant for the section of botany, in the place of Sir Joseph Hooker, elected Foreign Associate.—Remarks by General Sebert on the report of the French Association for the Advancement of Science.—On the longitude of the moon, by M. H. Andoyer. In the development of the co-ordinates of the moon in trigonometrical series by Delaunay, the coefficients are inexact. The correct coefficients, recalculated by two independent methods, are now given.—On a new calculating circle, by M. Pierre Weiss. The circular slide rule described has a diameter of 16 cm., and possesses an accuracy of 1 in 2000. It is claimed that this instrument is simpler in working than the ordinary straight form of slide rule.—On a relation between the coefficient of expansion and the melting-point of metals, by M. Lémeray. It is shown that if the coefficients of expansion of the metals are plotted against their absolute melting-points, the points lie roughly on a rectangular hyperbola.—The constant of universal gravitation. On a cause of asymmetry in the use of the Cavendish balance, by M. Marcel Brillouin.—The direct application of a telephonic receiver to wireless telegraphy, by MM. Popoff and Ducretet. A telephonic receiver for the Hertzian waves is described and figured. By its use the relays and the striker or automatic decoherer can be dispensed with, and the sensitiveness of the instrument is greatly increased, messages sent by a small Ruhmkorff coil (4 mm. spark) being easily made out at a distance of 500 metres, the ordinary arrangement with relays giving no response under the same conditions.—On the diurnal variation of atmospheric electricity, by M. A. B. Chauveau.—On the place of indium in the classification of the elements, by MM. C. Chabrié and E. Rengade. The assumption of an atomic weight of 113 for indium, corresponding to the oxide $In_2O_3$, is confirmed by the preparation of well characterised alums with cæsium and rubidium. The acetonylacetonate of indium was also prepared, in the hope of determining its molecular weight by means of its vapour density, but although a well-defined crystalline acetonylacetonate was obtained, it was not volatile.—Study of uranium nitrate, by M. Œchsner de Coninck. Solubility determinations in different organic liquids.—The crystalline form of the luteocobaltic chlorsulphate and chlorselenate, by M. T. Klobb.—On the osmosis of liquids through a membrane of pig's bladder, by M. G. Flusin. It has been shown in a previous communication that the velocity of osmosis of liquids through a membrane of vulcanised rubber varies in the same manner as the absorption capacity of the membrane for the liquids. The same relation has now been found to hold for a membrane of pig's bladder.—The anti-coagulating action of intravenal injections of the milk of one animal species upon the blood of animals of the same species, by M. L. Camus.—The cytological formula of the normal serosities of the pleura and peritoneum of the ox, by MM. J. Sabrazes and L. Muratet.—On the muscular serum, by M. Charles Richet. Muscle serum, although taken normally into the stomach as a food substance, produces strong toxic effects when injected under the skin. This effect is not produced after the serum has been coagulated by heat.—Indications of organic substances in certain mineral waters in the precipitate obtained with barium hydrate, by M. F. Garrigou.—On the common origin of the tissues of the leaf and stem in Phanerogams, by M. Léon Flot.—The presence of methyl alcohol in the fermented juices of several fruits, by M. Jules Wolff. The juices of the following fruits were examined:—black currants, prunes, mirabelle plums, cherries, pears, white and black grapes. After fermentation, the alcohol obtained was found to contain small quantities of methyl alcohol, varying from 2 per cent. for the spirit from black currants to 0·15 per cent. in that from grapes.

NEW SOUTH WALES.

**Royal Society**, November 7, 1900.—The President, Prof. Liversidge, F.R.S., in the chair.—Current Papers, No. 5, by H. C. Russell, C.M.G., F.R.S. This paper includes the records of 108 current papers collected during the past thirteen months. The total number of papers recorded in the whole series is now 602; these have been published in the Society's *Proceedings*. At this stage it is worth while to see what important results have been attained. Beginning, then, in the Indian Ocean, it is found that north of the Equator current papers drift to the eastward, but the number of papers found is too small to determine the rate of drift. From the Equator to latitude 10° south, current papers drift easterly on to equatorial Africa; five papers in this area made an average drift of 13·3 miles per day. Taking the next section, that is, from 10° south to 23° south, the average daily rate derived from eleven papers is 16·5 miles. From 23° south to 33° south, no papers have been found drifting westerly or easterly, except a few papers put afloat close to Australia, and they, as usual, went ashore. In the next area, *i.e.* between 33° south and 43° south, in the Indian Ocean, the current papers drift easterly, or, more accurately, east-north-east; twenty-one long distance papers in this area give an average daily drift of 7·6 miles. In the next section, *i.e.* 43° south to 50° south, twenty current papers show a daily easterly drift of 9·4 miles. Tabulating the dates at which current papers are found, it appears that the smallest number of current papers came ashore at the times of the *Equinoxes* (March and September), and the greatest number received in one month of each year is:—May 1897, ten papers; October 1898, twelve papers; August 1899, fourteen papers; and February 1900, fourteen papers.—The Sun's Motion in Space, Part i., History and Bibliography, by G. H. Knibbs. Apart from its intrinsic interest, the determination of the direction and quantity of the sun's motion in space is of importance, as the condition of further progress in developing a satisfactory system of defining the places of stars. The establishment of such fixed planes of reference as will be unaffected by the relative or absolute motions of the sun and stars, even for great periods of time, is clearly a desideratum, if not essential in any thorough scheme of analysis of such movements. The preliminary paper (Part i.) gives an account of the history and bibliography of the development of the idea of a motion of translation of the sun through space, and also of the determinations of the direction and amount of this motion, indicating briefly, at the same time, the general principles underlying those determinations. The conception of an indefinitely extended stellar universe, in which the sun and its planetary system is but a single and perhaps insignificant member, is one that the world owes to Giordano Bruno, in 1584. The part played by Bruno, Schyrleus, Fontenelle, Halley, Bradley, Wright, Kant, Mayer, Lambert, Michell and Lalande in establishing and extending the conception is indicated. The first deduction of the direction of the solar motion was made by Pierre Prévost in 1781 from twenty-six stars, the latest by Kobold from 2262 stars.—On a Eucalyptus oil containing sixty per cent. of geranyl acetate, by Henry G. Smith. In this paper the author shows that the oil of *Eucalyptus macarthuri*, known locally as Paddy's River Box, is very rich in geraniol, it containing 60 per cent. of geranyl acetate, and 10·64 per cent. of free alcohol, calculated as geraniol.

**Linnean Society**, Nov. 28, 1900.—Mr. Henry Deane, Vice-President, in the chair.—Notes on the botany of the interior of New

South Wales, Part ii., by R. H. Cambage. The vegetation met with in journeying from Cobar to the Bogan River above Nyngan, a distance of about 120 miles, is described, with special reference to the Eucalypts and their relation to geological formations.—On the Australian fairy-ring puff-ball (*Lycoperdon furfuraceum*, Schaeff.), by D. McAlpine. Bare circular patches met with in certain bowling-greens in the suburbs of Melbourne were found to be caused by a puff-ball which produced the appearance known as "fairy-rings." The puff-ball causing these rings is *Lycoperdon furfuraceum*, Schaeff., a fungus which has not hitherto been recorded from Australia, nor has it been found associated with "fairy-rings" in the Old World.—Studies on Australian Mollusca, Part iii., by C. Hedley.—Several molluscan genera new to Australia—*Blauneria*, *Stenothyra*, *Leuconopsis* and *Iravadia*—are here announced, all but the first-named of these being represented by new species. A new genus is erected for the reception of *Neritula lucida*, Ad. and Angas. New marine species from New South Wales, a new snail from Queensland, and records of new habitats conclude the article.—Note on an echidna with eight cervical vertebræ, by Dr. R. Broom. In a series of skeletons of echidna tabulated by McKay (*Proc.* Linn. Soc. N.S.W. (2), ix. 1894, p. 265) considerable variation in number is shown in all the groups of vertebræ with the exception of the cervicals. In the case now described, the eighth vertebra, which ought to be the first dorsal, is provided with a pair of quite rudimentary ribs, and is thus really a cervical vertebra.—On the ossification of the vertebræ in the wombat and other marsupials, by Dr. R. Broom. An examination of the mode of ossification of the vertebræ in a number of types of marsupials has revealed some interesting points. The odontoid process of the axis is ossified from a single median centre instead of from a pair as in man and probably most of the higher mammals. The 3rd-7th cervical vertebræ are ossified from three centres. The dorsal vertebræ are developed similarly to those in the higher mammals; and in the majority of marsupials the same may be said of the lumbar vertebræ. In the wombat (*Phascolomys mitchelli*), however, a remarkably interesting exceptional condition is presented. The first three lumbar vertebræ are developed from three centres as in man, but the fourth differs in having well-marked autogenous transverse processes.—Contribution to the bacterial flora of the Sydney water supply, Part ii., by R. Greig Smith. A *résumé* is given of the various methods that have been recommended for the selective examination of water and especially for the separation of *Bact. typhi* and *Bact. coli commune*.

## DIARY OF SOCIETIES.

*THURSDAY*, JANUARY 10.

MATHEMATICAL SOCIETY, at 5.30.—On the Singularities of Quartic Curves: A. B. Basset, F.R.S.—On Streaming Motions past Cylindrical Boundaries: Prof. Love, F.R.S.—On some Cases of the Solution of $x^{p^n} \equiv 1$, mod. $p$: Prof. F. S. Carey.—On the Zeroes of Bessel's Functions: E. W. Barnes.—A Proof of the Third Fundamental Theorem in Lie's Theory of Continuous Groups: J. E. Campbell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working: W. M. Mordey.——*And, if time permit*: The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure: John B. C. Kershaw.

*FRIDAY*, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.—On Mechanically Correcting the Rotation of the Field of a Siderostat: H. H. Turner.—On a Method of Reducing Occultations of Stars by the Moon, together with the Reduction of Occultations observed on Three Occasions at the Liverpool Observatory: H. C. Plummer.—On the Accuracy of Eye Observations of Meteors, and the Determination of their Radiant Point: Bryan Cookson.—Leonids observed at Cambridge Observatory, November 13-15, 1900: J. C. W. Herschel.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Geodesy: Wilfrid Airy.

MALACOLOGICAL SOCIETY, at 8.—On the Anatomy of *Helix ampulla* of Benson and its Generic position in the Ariophantinæ: Lieut.-Colonel H. H. Godwin-Austen.—A Third Report on Japanese Helicoid Land-shells: G. K. Gude.—On the Anatomy of *Buliminus djurdjurengis*, Ancey, from the Djurdjura Mountains, Kabylia: R. Murdoch.

*MONDAY*, JANUARY 14.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in the Canadian Rocky Mountains: Prof. Norman Collie, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Structure of Metals: Prof. J. A. Ewing, F.R.S.

*TUESDAY*, JANUARY 15.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—Third Contribution to the Ichthyology of Lake Tanganyika: G. A. Boulenger, F.R.S.—On some New and Interesting Exotic Spiders collected by Messrs. G. A. K. Marshall and R. Shelford: Rev. O. P. Cambridge, F.R.S.—Contributions to the Anatomy of Picarian Birds. No. IV. On the Skeleton of the Ground-Hornbills, *Bucorvus abyssinicus* and *B. caffer*: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: Glasgow Bridge: B. H. Blyth.—Railway Bridge over the Fitzroy River, at Rockhampton, Queensland: W. J. Doak.—The Niagara Falls and Clifton Steel Arch Bridge: L. L. Buck.——*Paper to be read, time permitting*: The Present Condition and Prospects of the Panama Canal Works: J. T. Ford.

ROYAL STATISTICAL SOCIETY, at 5.

*WEDNESDAY*, JANUARY 16.

SOCIETY OF ARTS, at 8.—Photography of Natural Colours by the McDonough-Joly Process: H. Snowden Ward.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address on the Climate of Norway and its Factors, by the President, Dr. C. Theodore Williams.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Address by the President.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.

*THURSDAY*, JANUARY 17.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—The Origin of Vertebrate Animals: Dr. Arthur Willey.

SOCIETY OF ARTS (Indian Section), at 4.30.—Metalliferous Mining in India: Dr. John W. Evans.

LINNEAN SOCIETY, at 8.—On the Affinities of *Aeluropus melanoleucus*, Prof. E. Ray Lankester, F.R.S., with a Description of the Skull and some of the Limb-bones: R. Lydekker, F.R.S.—On the Natural History and Artificial Cultivation of the Pearl Oyster: Dr. H. Lyster Jameson.

CHEMICAL SOCIETY, at 8.—The Preparation of Esters from other Esters of the same Acid: T. S. Patterson and Cyril Dickinson.—Tecomin: a Colouring Matter derived from *Bignonia tecoma*: T. H. Lee.—A New Method for the Measurement of Ionic Velocities in Aqueous Solution: B. D. Steele.—Metal-Ammonia Compounds in Aqueous Solution. II. The Absorptive Powers of Dilute Solutions of Salts of the Alkali Metals: H. M. Dawson and J. McCrae.

*FRIDAY*, JANUARY 18.

ROYAL INSTITUTION, at 9.—Gases at the Beginning and End of the Century: Prof. J. Dewar, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—*Possibe* discussion upon Mr. H. A. Humphrey's paper on Power Gas and Large Gas-Engines for Central Stations.

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